SCIENTIFIC AGRICULTURE

Vol. XVI AUGUST, 1936 No. 12

TREE INJECTIONS WITH BORON AND OTHER MATERIALS AS A CONTROL FOR DROUGHT SPOT AND CORKY CORE OF APPLE[1]

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[Received for publication June 26, 1936]

In this paper there are presented the preliminary results of an experiment on the control of drought spot and corky core of apple (*7*, *8*, *9*, *10*). These two physiological disorders of the apple fruit cause serious economic losses in the Okanagan and Kootenay valleys of British Columbia and the present paper deals with one phase of an extensive investigation of these disorders which has been undertaken jointly by the Divisions of Horticulture, Chemistry and Botany of the Experimental Farms System. This experiment has consisted of a series of injections into the trunks and main limbs of diseased trees, such nutrient materials being used as it was thought might have a beneficial effect on the control of these disorders. The work reported covers the period from 1932 to 1935.

LITERATURE

The value of injecting material into trees, either to protect them against insect and fungous attack (*3*, *12*, *13*, *14*, *15*), or to supply them with an increased amount of necessary food material (*5*, *16*), has been tested by many investigators over a considerable number of years. The injection of nutrient salts has been used as a means of control for several physiological disorders in tree fruits (*12*, *16*). Such diseases as "little leaf" of pecan (*6*), peach and apple (*4*, *11*), exanthema of apple (*17*), lime-induced chlorosis of apple and pear (*2*), and various other disorders have been controlled by injecting the deficient nutrient salts into the trunks or main limbs of affected trees. Recently injections of boron have proved effective in eliminating or reducing the amount of cork in apples in New Zealand (*1*).

The technique usually employed by the various investigators consisted of boring holes into the trunk or main limbs of the tree to be treated, and either packing these holes with the dry chemical, or connecting each by means of tubing to a reservoir containing an aqueous solution of the material.

MATERIALS USED AND METHOD OF INJECTION

The suggestion that drought spot and corky core might respond to this method of treatment originated from the fact that a partial control of these diseases had been obtained in earlier experiments, when heavy applications of a potash fertilizer were made to affected trees. It was hoped that a direct injection of a soluble potassium salt might be the means

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of bringing about an immediate and complete recovery. Accordingly, in this series of injections, special attention was given to the potassium salts, although other materials were also used. These materials included the following nutrient elements: nitrogen, phosphorous, potassium, magnesium, calcium, copper, iron, zinc, manganese, sodium, and boron. Some liquid injections were made at the beginning; but throughout the experiment, the "dry salt" method was used almost entirely, partly because of its greater convenience in handling, and partly because it permitted larger quantities of material to be injected without causing injury to the foliage.

In this paper, an "injection" is taken to mean the filling of a single hole with any chemical or combination of chemicals. By a "treatment" is meant the injecting into a tree of the total amount or "dose" of such chemicals determined upon. A treatment might consist of any number of injections. A chemical or nutrient element was "tested" when it was used either alone or in combination with others in a treatment.

The trees treated were all located in one orchard, a twenty-three acre block, which was chosen and taken over by the Department because of the prevalence of these diseases. The soil was a light, sandy loam with a depth of one to two feet, under which lay coarse gravel. The orchard was 20 years old in 1932, and the varieties treated included McIntosh, Wealthy, Duchess, and Jonathan. In this block, individual tree records had been kept for two years previous to the beginning of the experiment, and only those trees were chosen for curative treatment on which at least 25% of the crop had been affected with either drought spot or corky core. In addition, a small number of trees which had produced normal crops were treated with materials designed to induce these diseases.

In the first year's work, most of the treatments made were on limbs not less than 2 inches in diameter, and frequently a number of limbs on the same tree were treated with different materials. In the second and third years, the practice followed was to make the injections into the trunk, and to treat a whole tree with only one material or one combination of materials. The position of the holes in the trunk was below the lowest limbs, at a convenient boring distance from the ground and the holes were bored at right angles to the surface. The depth of the holes varied from approximately one inch to the full depth of the auger (7 inches), and they were usually spaced from 4 to 6 inches apart around the circumference. When a large quantity of material was to be used, they were made full depth and spaced 2 to 3 inches apart, each hole being placed slightly above the preceding one so that the series formed a spiral around the trunk. In the majority of cases, the treatments were given during the summer months, though with some materials they were continued throughout the year.

The materials used were tested, usually, both individually and in various combinations with each other. In a few cases, however, combinations were used in which not all the individual component parts were tested separately. Where combinations were used, the usual practice was to mix the chemicals before injection, rather than to inject each into a separate hole. With the exception of potassium sulphate and superphosphate, C.P. chemicals were used; these two exceptions were of the purity as supplied in commercial fertilizers.

As a basis for determining the quantity of each material to be injected, the total content of that material present in a normal tree was estimated from tables of ash analysis. The weights used per tree were then varied from relatively small amounts up to and exceeding the total estimated normal content. With potassium sulphate, for instance, the amount injected ranged to as high as 212 grams in a tree of approximately 8 inches in trunk diameter, and with boric acid to 21 grams in a tree of similar size. When a uniform system of packing the holes had been developed, the amount of each salt or salt combination per inch in depth of hole was determined and found to be constant. This amount served as a means of calculating the quantity applied to each tree.

The equipment used (Figure 1), and the technique of injection finally adopted, were as follows. A seven-sixteenth inch auger was chosen as a convenient size for the holes, being large enough to permit the injection of

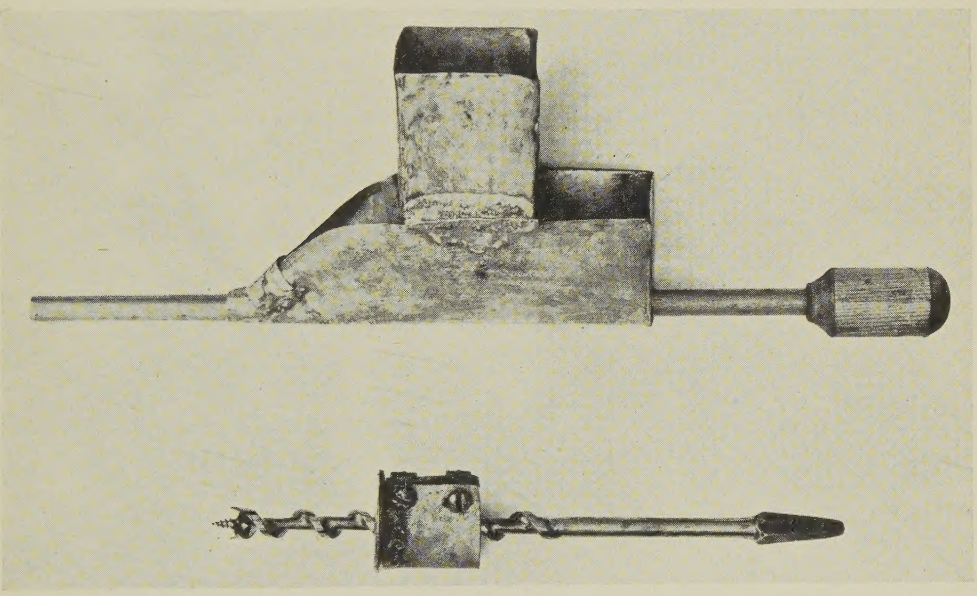

FIGURE 1. Injector and auger with adjustable stop.

the amounts of material desired, and yet not so large as to cause undue injury to the trunk of the tree. To the auger was attached an adjustable stop with which holes of any required depth could be readily made. A convenient injector was made from pieces of galvanized iron to serve as a holder, and a metal rod, three-eighth inch in diameter, to be worked as a plunger. One piece of iron, about 5 by 6 inches, was rolled to form a trough. At one end of this trough, the corners were cut away, and the edges rolled in, to form a slightly tapered tubular spout. This spout was constructed to fit neatly into the seven-sixteenth inch hole when inserted to a depth of one-quarter inch, and at the same time to be of sufficient inside diameter to allow the three-eighth inch rod to slide through it freely. The opposite end of the trough was closed by soldering in a piece of iron of suitable size, through which had been bored a seven-sixteenth inch hole,

placed to come exactly opposite the spout in the other end. Through this hole, the plunger was inserted, to slide along the bottom of the trough and out through the spout. For convenience, a wooden handle was attached to the outer end of the plunger. A small hopper of about 75 grams capacity was then constructed, with the hole at the bottom just large enough to let the material flow through readily. This hopper was soldered into the trough, with just sufficient clearance to let the rod slide beneath it.

The procedure adopted was first to bore all the holes in one trunk to the depth required. A supply of material was then placed in the hopper, and the spout of the injector pressed firmly into a hole. With successive strokes of the plunger, the material was packed in. After each stroke, the plunger was withdrawn beyond the hopper mouth, allowing a new supply of material to come down. When deep holes were being filled, some care was necessary to make certain that the plunger "packed home" the material at each stroke; otherwise, cavities in the packed salt resulted. The packing was continued until the material was well up into the spout. The injector was then withdrawn and applied to the second hole and the process continued until the treatment was completed. By having the spout enter the hole to a one-quarter inch depth, and by packing the material firmly all the way—even well up into the spout—it was found that, when the injector was removed, the material usually broke neatly at the end of the spout. In this way, the cambium tissue was protected from coming into direct contact with the injected material. The holes were then sealed by filling them to the surface with emulsified asphaltum.

METHOD OF RECORDING AND EVALUATING RESULTS

When injections in any one year were made after the blossom period, the results of the treatment were recorded on the following year's crop. When they were applied before the blossom period, they were recorded with that year's crop. This allowed some time for the absorption of the materials and for their influence to become effective.

The results of each treatment on drought spot were recorded in late June or early July by counting at random 100 apples on each tree and estimating the general percentage of disease present. All apples showing any drought spot were counted as diseased. The counts for corky core were taken at the time of picking and were secured by cutting open 50 apples on each tree. From this count the percentage of disease was estimated.

In obtaining the data on the influence of any particular material in controlling the disease the total count of the number of tests with that material was obtained as follows: Every time a material was used in any treatment, whether alone or in combination with others, there was recorded for it one test. Thus when any treatment was composed of a combination of chemicals, four for instance, there were recorded four tests, one for each chemical respectively. An exception was made to this method where mixtures contained boron. The effect of boron on the control of these diseases was so pronounced that its presence obscured the influence of the other materials; in such combinations accordingly the other materials were not recorded as being tested. By this method the number of tests

recorded under an individual chemical signified the number of trees treated therewith, except in the first year's work when two-inch limbs were used. In evaluating the influence of any single chemical, the resultant percentages of drought spot and corky core on the trees treated with that chemical were averaged, and a comparison was made between these averages and the average percentages of disease on the same trees the year previous to treatment. In addition, comparative data were recorded on 30 similarly diseased but untreated trees.

Each of the chemicals used contained one or more nutrient elements. The treatments made with these chemicals constituted, therefore, a series of tests on various elements and permitted an evaluation of either their individual or collective influence. This evaluation was based on the results obtained from the total number of tests in which each of these elements was used in the various treatments.

In the tests with boron, where a definite response was found, additional details are presented for the 1934 tests. These include the tree number, variety, date of treatment, amount of material used (expressed in weight of BO_3 per 100 square centimeters (15.5 square inches) of trunk cross-sectional area) and the crop produced (expressed in loose boxes of saleable fruit).

RESULTS

The general results are presented in Table 1. Over the three-year period there were tested 30 different chemicals. When these are considered on a basis of their nutrient element contents, it is shown that potassium was tested 171 times, nitrogen 32, phosphorous 37, magnesium 36, calcium 20, copper 6, iron 12, zinc 7, manganese 3 (not including 31 tests where manganous borate was used), sodium 2, and boron 44 times.

With the exception of boron, none of these elements have had any significant effects on the disease in the subsequent year's crop. In the few injections made to induce these diseases, some response was indicated with the use of calcium nitrate; but the small number of tests involved precluded any conclusive judgment of its value.

Where boron was used in the form of manganous borate or boric acid, either alone or in combination with other materials, a definite response was evident. Table 2 presents in detail the results with these two materials from the 1934 treatments. The table is arranged in accordance with the amounts of BO_3 used per one hundred square centimeters of trunk cross-sectional area. These tests were made on McIntosh and Jonathan, as indicated.

When an amount of borate greater than .48 gram was used, all drougth spot was eliminated from the 1935 crop. When an amount greater than 1.83 grams was used, all corky core was controlled. The average crop per treated tree in 1934 was 3.61 boxes, and in 1935 was 10.6 boxes. In the 30 check trees the average percentage of drought spot in 1935 was 10% greater, and the average corky core was 7% less than in 1934, while the average crop per tree decreased from 3.8 to 2.5 boxes of saleable fruit.

No foliage injury has been apparent even when the maximum amount of BO_3 (5.92 grams per 100 square centimeters of trunk cross-sectional area) was injected; on the other hand, the leaf scorch symptoms frequently

TABLE 1.—RESULTS OF TREATMENTS WITH VARIOUS CHEMICALS ON GOVERNMENT-LEASED ORCHARD, KELOWNA, B.C., 1932–1935

Material	1932–1933 Treatments					1933–1934 Treatments					1934–1935 Treatments				
	No. of tests	Av. % disease 1932 DS*	Av. % disease 1932 CC*	Av. % disease 1933 DS	Av. % disease 1933 CC	No. of tests	Av. % disease 1933 DS	Av. % disease 1933 CC	Av. % disease 1934 DS	Av. % disease 1934 CC	No. of tests	Av. % disease 1934 DS	Av. % disease 1934 CC	Av. % disease 1935 DS	Av. % disease 1935 CC
Ammonium carbonate	3	38	4	37	28	1	98	84	100	60					
Ammonium nitrate	3	38	4	33	28	1	100	84	100	60					
Ammonium phosphate	3	38	4	37	28	2	49	42	85	40					
Ammonium tartrate	3	38	4	49	28	1	100	84	100	60					
Ammonium sulphate	3	38	4	38	33										
Calcium citrate	3	38	13	33	33	1	94	84	100	60					
Calcium chloride	1	0	0	51	24										
Calcium nitrate											3	0	0	9	5
Calcium phosphate	6	52	5	57	53	2	99	92	85	75	1	0	0	0	0
Calcium sulphate	3	66	5	80	73										
Copper acetate						2	92	96	82	43					
Copper sulphate	3	38	4	38	33	1	80	84	100	NC					
Ferric citrate											10	84	86	88	85
Ferrous sulphate	2	100	8	95	98										
Potassium carbonate	5	57	10	49	41	12	80	63	77	50					
Potassium chloride	2	85	20	62	74	4	75	47	27	71					
Potassium citrate	3	38	4	38	28	11	82	56	72	50	11	67	60	79	56
Potassium dihydrogen phosphate	5	57	10	54	46	2	58	62	48	74					
Potassium hydrogen phosphate	3	38	4	36	28	6	90	86	84	54					
Potassium nitrate	5	53	4	45	47										
Potassium permanganate	3	38	4	28	28	3	85	89	100	70					
Potassium sulphate						73	62	71	42	23	23	35	24	53	61
Magnesium ammonium phosphate	3	38	4	33	28	1	100	84	100	60					
Magnesium carbonate	4	28	3	40	27										
Magnesium sulphate	4	92	14	77	80	24	49	59	48	29					
Sodium chloride	2	100	8	95	98										
Superphosphate	3	38	4	38	28										
Zinc sulphate						7	46	50	86	49					
Boric acid						4	80	88	2	7	9	74	52	0	9
Manganous borate											31	58	39	2	15
30 check trees		38	31	57	51		57	51	54	48		54	48	64	43

*DS—Drought spot. CC—Corky core.

accompanying drought spot and corky core were almost entirely eliminated. In all cases, however, some injury occurred at the point of injection. From the 1934 injections, the bark and cambium were killed back from two to three inches above and below the hole, and from one-half to one inch on either side. Injuries from the other materials applied in the dry form varied according to the nature of the material; but in no case was there very serious foliage damage. Liquid injections, however, frequently caused serious injury two to three days after treatment. The contrast between liquid and dry salt injection may well be illustrated in the case of potassium sulphate, where 40 grams in a liquid injection caused severe foliage injury, although as much as 212 grams in a single dry salt treatment had no injurious effect.

TABLE 2.—RESULTS OF TREATMENTS WITH BORON ON GOVERNMENT-LEASED ORCHARD, KELOWNA, B.C., 1934–1935

Variety and Tree No.	Per cent disease 1934		Date of injection	Wt. borate used†	Per cent disease 1935		Crop‡	
	DS %	CC* %		gm.	DS %	CC %	1934 boxes	1935 boxes
M§—KK2	12	80	17/12/34	0.21	0	4	0.0	24.0
J—LL3	48	80	17/12/34	0.27	27	28	9.5	2.5
M—GG12	50	0	27/12/34	0.28	0	8	0.0	12.0
J—W17	85	40	26/1/35	0.32	4	12	6.5	12.0
M—GG24	80	15	9/2/35	0.35	0	40	0.0	13.0
M—R18	20	20	7/8/34	0.42	4	48	7.5	7.0
M—Z14	76	28	7/8/34	0.42	8	40	4.0	6.5
J—X17	85	20	2/2/35	0.45	0	0	2.0	11.5
J—X18	65	25	2/2/35	0.48	0	8	3.0	6.0
M—JJ19	40	0	7/8/34	0.48	0	4	3.0	15.0
M—P16	84	56	7/8/34	0.48	12	39	0.0	5.0
M—GG11	28	36	8/8/34	0.49	0	68	3.5	5.0
M—K6	44	32	7/8/34	0.50	0	44	8.5	6.0
J—W19	90	85	26/1/35	0.50	0	4	1.5	12.0
M—I5	40	12	7/8/34	0.51	0	4	14.5	8.0
M—HH17	NC	NC	9/1/35	0.53	0	0	0.0	0.0
M—JJ12	32	0	7/8/34	0.53	0	12	5.5	16.0
M—AA15	52	12	7/8/34	0.54	0	32	5.0	8.0
M—GG18	100	33	25/1/35	0.54	0	0	0.0	1.1
M—FF21	92	67	3/1/35	0.55	0	16	0.0	6.0
M—HH14	NC	NC	9/1/35	0.55	0	24	0.0	8.0
M—S14	44	40	7/8/34	0.61	0	12	8.0	6.0
M—Q5	68	20	7/8/35	0.61	0	8	10.5	11.0
M—AA14	60	16	8/8/34	0.70	0	8	10.5	22.0
M—J10	48	48	7/8/34	0.93	0	0	0.0	10.0
M—CC14	100	68	8/8/34	1.21	0	28	0.0	16.5
M—GG5	36	68	7/8/34	1.38	0	0	7.5	4.0
M—J5	60	40	7/8/34	1.45	0	0	6.5	11.0
M—K9	56	64	7/8/34	1.49	0	0	0.0	10.5
M—L9	72	64	7/8/34	1.59	0	0	0.0	11.0
M—BB18	44	16	7/8/34	1.83	0	8	4.0	15.0
M—II19	50	0	7/8/34	2.00	0	0	10.0	14.0
M—U18	52	100	7/8/34	2.13	0	0	0.0	16.0
M—J11	84	36	7/8/34	2.51	0	0	0.0	7.0
M—FF11	64	32	7/8/34	2.65	0	0	5.5	18.0
M—K11	68	96	7/8/34	3.56	0	0	0.0	11.0
M—LL16	100	20	7/8/34	3.90	0	0	0.0	15.0
M—L10	48	84	7/8/34	4.12	0	0	0.0	5.0
M—KK18	96	18	7/8/34	5.10	0	0	0.0	19.0
M—U19	50	45	7/8/34	5.92	0	0	8.0	16.0
30 check trees average	54	48			64	43	3.8	2.5

*Drought spot and corky core.
†Indicates the weight of BO_3 per 100 sq. cm. (15.5 sq. in.) of trunk cross-sectional area.
‡Number of loose boxes of saleable fruit.
§M—McIntosh. J—Jonathan.

SUMMARY

1. Thirty chemicals were injected during the period of 1932 to 1935, to test their influence on the occurrence of drought spot and corky core in apples.

2. These chemicals were used individually and in various combinations with each other.

3. Significant controls of both drought spot and corky core were obtained when boric acid and manganous borate were used, either individually or in combination with the other chemicals.

4. When more than 0.48 gram of BO_3 was used per 100 square centimeters of trunk cross-sectional area, no drought spot occurred in the following year's crop. When more than 1.83 grams were used no corky core occurred.

5. The average crop of saleable fruit from trees treated with boron was increased in one year from 3.61 to 10.6 boxes per tree, whereas on the check trees it fell on the average from 3.8 to 2.5.

6. No foliage injury was evident with the amounts of BO_3 used, *i.e.*, up to 5.92 grams. Slight injury occurred at the points of injection.

ACKNOWLEDGMENTS

Acknowledgment is made with thanks, to Mr. J. C. Wilcox, horticulturist in charge of the orchard, for the supplying of various records, and to Mr. T. B. Lott of the Laboratory Staff for assistance with the injections.

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Résumé

Injections de bore et d'autres matériaux dans les arbres pour prévenir la tache de sécheresse et le cœur liégeux de la pomme. H. R. McLarty, Laboratoire fédéral de pathologie végétale, Summerland, C.-B.

Pendant la période allant de 1932 à 1935 il a été fait des injections de trente ingrédients chimiques différents, pour déterminer l'effet de ces ingrédients sur la tache de sécheresse et le cœur liégeux des pommes. Ces ingrédients ont été employés séparément, ainsi qu'en différentes combinaisons l'un avec l'autre. On a obtenu un contrôle significatif de la tache de sécheresse aussi bien que du cœur liégeux lorsque l'acide borique et le borate manganeux étaient employés séparément ou en combinaison avec les autres ingrédients. Lorsque la quantité de BO_3 employée était en excès de 0.48 gramme par 100 centimètres carrés d'une section en travers du tronc, il n'y a eu aucune tache de sécheresse dans la récolte de l'année suivante. Lorsque la quantité employée dépassait 1.83 gramme il n'y a pas eu de cœur liégeux. La récolte moyenne de fruits marchands produits par les arbres traités avec du bore a été augmentée en une année de 3.61 à 10.6 caisses par arbre, tandis que sur les arbres témoins, non traités, elle est tombée en moyenne de 3.8 à 2.5. Avec les quantités de BO_3 employées, c'est-à-dire jusqu'à 5.92 grammes, il n'y a eu aucune détérioration du feuillage. Une légère détérioration s'est produite aux points d'injection.

IRRIGATION OF CANTALOUPES[1]

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[Received for publication June 17, 1936]

Cantaloupes are grown extensively in the Okanagan Valley of British Columbia. Most of the commercial acreage is in the Oliver-Osoyoos district, which has a long, warm, growing season. The soil in this district is comparatively light. There is abundance of irrigation water available and there has been a tendency to use large quantities of water in growing cantaloupes. General observations suggested that this practice of heavy irrigation reduced the yield and injured the quality of the resulting melons. Search of the literature revealed a lack of reliable experimental evidence on this subject. Accordingly, to secure accurate information concerning the irrigation requirements of cantaloupes, the experiments reported in this paper were conducted at the Summerland Experimental Station during the years 1933, 1934 and 1935.

MATERIAL AND METHODS

Planting Procedure

A block of ground extending 224 feet along a flume and 105 feet wide was chosen for this experiment. Twenty-eight rows 8 feet apart by 105 feet long were measured out. The first row was left as a buffer row and the remaining 27 rows were grouped into 9 plots each consisting of 3 rows. Hale's Best cantaloupes were seeded in the greenhouse in flats, and well grown plants set out in the rows, 3 feet between plants, 33 plants per row. Each plant was protected by a Hotkap and replacements were made to fill any gaps during the first two weeks after planting out. The centre row in each plot was regarded as a test row with a guard row on each side.

Character of the Soil

This piece of ground had been used for general vegetable growing for 16 years. Different vegetables had been grown in rotation and annual applications of 5 tons of barnyard manure per acre had been given. Originally the ground had been very uneven and a good deal of grading and levelling had been done. This resulted in difference in depth of soil in various places, and the occurrence of what had once been surface soil at considerable depths in some plots. A mechanical analysis was made of the soil in each plot. Two pits were dug in each test row near the top (A) and near the bottom (B) respectively and numbered the same as the row from which they were taken. Soil samples were taken whenever any change in soil colour or texture was noticed and the depth of each soil layer recorded. All samples were sent to Mr. C. C. Kelly, Officer-in-charge of Soil Survey, Kelowna, who made mechanical analyses of the soil by the

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Bouyoucos method (*1*). The soil was classified according to the standards used by the Bureau of Soils, United States Department of Agriculture. The results of these analyses are given in Table 1. Generally speaking the soil is a sandy loam overlying coarse sand and gravel providing excellent drainage. It would be classed as good commercial cantaloupe ground.

TABLE 1.—MECHANICAL ANALYSES OF SOIL SAMPLES BY BOUYOUCOS HYDROMETER METHOD

Row	Depth from surface	Class	Row	Depth from surface	Class
	inches			inches	
3A	0– 6	Loam	3B	0–10	Sandy loam
	6–42	Sandy loam		10–22	Silt loam
	42–	Gravel		22–34	Loam
				34–38	Silty clay
				38–60	Coarse sand
				60–	Gravel
6A	0–10	Loam	6B	0–20	Loam
	10–23	Silt loam		20–27	Sandy loam
	23–25	Clay		27–38	Clay loam
	25–49	Sandy loam		38–	Gravel
	49–	Gravel			
9A	0–24	Sandy loam	9B	0–28	Sandy loam
	24–28	Sand		28–33	Loamy sand
	28–36	Coarse sand		33–44	Sandy loam
	36–44	Sandy loam		44–	Gravel
	44–54	Coarse sand			
	54–	Gravel			
11A	0–10	Loam	11B	0–10	Loam
	10–48	Sandy loam		10–31	Silt loam
	48–	Gravel		31–39	Loamy sand
				39–	Gravel
15A	0–37	Sandy loam	15B	0–10	Loam
	37–	Gravel		10–46	Silt loam
				46–52	Sand
				52–	Gravel
18A	0–43	Sandy loam	18B	0–10	Loam
	43–	Gravel		10–30	Silt loam
				30–52	Sandy loam
				52–	Gravel
21A	0–22	Sandy loam	21B	0–10	Sandy loam
	22–28	Loam		10–19	Loam
	28–40	Sand		19–26	Sandy loam
	40–	Gravel		26–58	Loamy sand
				58–	Gravel
24A	0–15	Sandy loam	24B	0–23	Sandy loam
	15–44	Sand		23–29	Silt loam
	44–	Gravel		29–51	Sand
				51–	Gravel
27A	0–10	Loamy sand	27B	0–28	Sandy loam
	10–17	Sandy loam		28–31	Silt
	17–26	Loamy sand		31–53	Sand
	26–50	Sand		53–	Gravel
	50–	Gravel			

Applying the Water

All water applied to the plots was measured by means of the measuring device described previously (*3*). When rainfall occurred, deductions were made from irrigations whenever the rain amounted to 0.10 inches or over. The water was applied by the furrow method, a furrow being placed on each side of each row, at first 12 inches and later 18 inches from the plants, for the irrigations given during May and June. The furrows were cultivated in after each irrigation until growth of the plants prevented this procedure, when permanent furrows were put in 24 inches from the plants. Weeds were kept hoed throughout the growing season. By careful management no run-off or waste of water was permitted and very uniform distribution of water was obtained. For the first season, water was applied at the rate of ½ inch, 1 inch, 1½ inches and 2 inches per week. From results obtained in 1933, it was quite evident that 2 inches per week was too much water for cantaloupes and this rate of application was omitted in 1934. As again the lightest application of water gave the heaviest yields, the 1½ inch per week was omitted in 1935 and a minimum of ½ inch once in two weeks was tried. It was found impractical to attempt to apply less than ½ inch at one irrigation as it was impossible to secure uniform distribution of the water throughout the length of the row.

Soil Moisture Determinations

To secure information regarding the amount of moisture present in the soil throughout the season, soil moisture determinations were made regularly. Samples were taken at a depth of 6 inches in three different locations in the centre row in each plot. The three samples were mixed to form a composite sample. Similarly, three samples were taken at 18 inches in depth in the same holes in the same rows. These were again mixed to form composite samples. The percentage of moisture in each

sample was determined by drying to constant weight in an electric oven at 100° C. These moisture determinations were made just before the irrigation commenced each week and again the morning after each irrigation was completed. By this procedure, information was secured concerning the amount of irrigation water retained in the upper layers of the soil, and the amount which leached down below a depth of 18 inches.

Recording Crop Response

Each row was harvested separately. Very little difference in yield was observed between guard and test rows in the same plot receiving the same water, whereas significant differences were noted between adjoining rows receiving different amounts of water, indicating that there was little lateral spread of water from one row to another. Accordingly, the average of three rows was taken for each plot instead of yields from test rows only.

In addition to the number of melons per row, the number of high-grade melons, that is, those grading sizes 36 and 45 to the crate, which are most in demand and bring highest prices, were recorded. Further, it was thought there might be a relation between the amount of irrigation applied and the production of poorly netted melons known locally as "slickers", so the number of these per row was also recorded.

PRESENTATION OF DATA

Influence of Amount of Water Applied on Yield and Grade of Cantaloupes

A summary of the total number of melons, the number of high-grade melons and the number of slickers per row is given in Table 2. As each test was made in triplicate, the yields given are the average of three plots of three rows each except for 1933 where the yields are the average of seven rows in each test.

TABLE 2.—INFLUENCE OF AMOUNT OF WATER APPLIED ON YIELD AND GRADE OF CANTALOUPES

Year	Total number of cantaloupes per row				
	Depth of weekly application				
	*¼ inch	½ inch	1 inch	1½ inches	2 inches
1933	–	245	238	209	192
1934	–	257	216	210	–
1935	186	206	196	–	–
	Number of high-grade cantaloupes per row				
1933	–	163	162	131	126
1934	–	188	143	142	–
1935	89	102	98	–	–
	Number of slickers per row				
1933	–	4.7	6.3	11.3	13.1
1934	–	1.8	1.7	2.1	–
1935	5.1	2.9	2.8	–	–

* ½ inch once a fortnight is expressed for comparison as ¼ inch per week.

From these data it may be noted that applications of ½ inch per week gave not only the largest total yield, but also the largest number of high-grade melons, and at the same time gave a low number of slickers. In 1933 the heaviest watered plots gave the most slickers, while in 1935 the very light watered plots gave the most slickers.

Influence of Amount of Water Applied in Successive Years

The reduction from four different rates of application in 1933 to three rates in 1934 resulted in different amounts of water being applied to the same row in the different years and made possible a comparison of yields from the same row with different amounts of water. This comparison is shown in Table 3.

TABLE 3.—COMPARISON OF YIELDS FROM THE SAME ROW WITH DIFFERENT APPLICATIONS OF WATER

Row	1933		1934		Water		Yield	
	Water	Yield	Water	Yield	Increase	Decrease	Increase	Decrease
	inches	melons	inches	melons	inches	inches	melons	melons
1	½	188	½	191	–	–	3	–
2	½	234	½	232	–	–	–	2
3	½	226	½	252	–	–	26	–
4	½	295	½	268	–	–	–	27
5	1	243	1	242	–	–	–	1
6	1	235	1	220	–	–	–	15
7	1	262	1	265	–	–	3	–
8	1	303	1½	214	½	–	–	89
9	1½	203	1½	203	–	–	0	–
10	1½	242	1½	285	–	–	43	–
11	1½	231	½	319	–	1	88	–
12	1½	242	½	304	–	1	62	–
13	2	226	½	266	–	1½	40	–
14	2	203	1	254	–	1	51	–
15	2	184	1	226	–	1	42	–
16	2	215	1	247	–	1	32	–
17	½	267	1½	292	1	–	25	–
18	½	265	1½	239	1	–	–	26
19	½	251	1½	246	1	–	–	5
20	1	237	½	305	–	½	68	–
21	1	187	½	216	–	½	29	–
22	1	200	½	215	–	½	15	–
23	1½	191	1	201	–	½	10	–
24	1½	188	1	201	–	½	13	–
25	1½	171	1	213	–	½	42	–
26	2	201	1½	221	–	½	20	–
27	2	153	1½	188	–	½	25	–
28	2	162	1½	188	–	½	26	–

It will be noted that 9 rows received the same rate of application in 1934 as in 1933. Five of these rows gave almost identical yields, 2 gave lower yields and 2 gave higher yields, leaving the average of the 9 rows almost identical for the two years. Four rows got more water in 1934 than in 1933. Three of these rows gave lower yields and one gave an increase. Fifteen rows received less water and in every case yields were increased.

Correlation of Soil Moisture and Yield

Soil moisture determinations were made before and after each irrigation on one row in each plot. The difference in percentages between the two may be considered indicative of the amount of water retained by the soil at each irrigation. It was noted that between the close of one irrigation and just preceding the next irrigation, there was generally a drop in soil moisture content. Presuming that the evaporation from all plots was about the same, the difference between the percentage of moisture at the close of one irrigation and the percentage at the beginning of the next may be considered indicative of the amount of water used by the crop on each row during the interval. The correlation between the yields and the amount of water retained and used is shown in Table 4. The average percentage throughout the 12 weeks was used for each row.

TABLE 4.—CORRELATION BETWEEN SOIL MOISTURE AND YIELD

Row number	12	3	18	15	6	21	9	24	27
Water applied in inches	$\frac{1}{2}$	$\frac{1}{2}$	$1\frac{1}{2}$	1	1	$\frac{1}{2}$	$1\frac{1}{2}$	1	$1\frac{1}{2}$
Yield of row	304	252	339	226	220	216	203	201	188
Per cent water retained at 6″	26.0	32.8	31.8	41.9	41.0	21.7	43.1	45.8	32.5
Per cent water retained at 18″	6.2	6.5	17.0	9.7	18.6	3.1	12.9	14.3	20.1
Average per cent 6″ and 18″	16.1	19.7	24.4	25.8	29.8	12.4	28.0	30.1	26.3
Per cent water used at 6″	28.5	34.1	29.4	41.8	18.3	22.6	40.2	42.1	28.6
Per cent water used at 18″	11.0	8.8	17.1	9.6	9.3	4.2	9.8	8.7	18.0
Average per cent 6″ and 18″	19.8	21.5	23.3	25.7	27.6	13.4	25.0	25.4	23.3

The data presented in Table 4 indicate that there was a tendency for the yield to decrease as the amount of water retained in the soil and used by the plants increased. It will be noted, however, that row No. 21 which retained and used the lowest percentage of soil moisture, produced a comparatively light crop. Furthermore, row No. 18 which retained and used comparatively large amounts of water, produced a comparatively high yield. These results suggest that while the amount of water retained by the soil and used by the plants may be partly responsible for the reduction in yield from heavily irrigated plots there are other factors of equal if not greater importance. In this connection, it is interesting to note that the physical analyses of soil presented in Table 1 show a layer of sand comparatively near the surface in rows 9, 21, 24 and 27, the four rows which gave the lowest yields.

Influence of Amount of Water Applied on Soil Fertility

Results from the three years' tests indicate that lightly irrigated plots produced the largest crops and the highest quality melons. In an endeavour to ascertain the explanation, the effect of the irrigation treatments on available plant nutrients was considered. An examination of the data revealed that 6 rows had received light applications of water in all three seasons, each receiving a total of 15 or 21 inches of water in the three growing seasons. Two composite samples of soil were taken from these

rows. Sample 1A was a composite sample of the first 10 inches of soil in these rows. Sample 1B was a composite sample of the soil at a depth between 10 and 18 inches in each of the same rows. In contrast to these lightly watered rows, 5 rows had consistently been given heavy applications of water, each row receiving a total of 48 or 54 inches of water for the three growing seasons. Soil samples were taken from these rows in a manner similar to those from the lightly watered rows. Sample 2A was a composite sample of the first 10 inches of the heavily watered rows and sample 2B was a composite sample of the soil at a depth of 10 to 18 inches of the same rows.

These samples were forwarded to the Horticultural Laboratory, University of British Columbia, and an analysis was made by Mr. C. A. Hornby, an undergraduate student. These samples were analyzed for available plant nutrients by the Spurway method of soil testing (*5*).

Results obtained by this method may be considered indicative rather than conclusive. In Table 5 some of the results of these analyses are shown (*4*).

TABLE 5.—AVAILABLE SOIL NUTRIENTS IN PARTS PER MILLION

Soil sample	Depth	Water	Nitrates	Phosphorus	Nitrites	Ammonia
	inches					
1 A	0–10	Light	5	1	0.5	1
1 B	10–18	Light	10	4	0.0	1
2 A	0–10	Heavy	2	1	0.0	0
2 B	10–18	Heavy	2	4	0.0	0

In filtering the soil solutions it was noted that the filtrate of the samples from the lightly watered plots 1A and 1B remained slightly cloudy even after four filterings. However, the soil solution from the top soil (2A) of the heavily watered plots came through clear in the first filtering and the solution from the lower soil sample (2B) of the heavily watered plots came through clear after the second filtration. This suggests that samples from the light watered plots contained more colloidal materials.

The significant feature of this analysis is the much lower nitrate and ammonia content of the soils from the heavily watered plots, indicating that leaching of nitrogen below the 18-inch level had taken place. The cantaloupe is a shallow-rooted plant, the majority of the roots being located in the top 10 inches of soil (*6*). Accordingly, the leaching of nitrogen from the upper layers of the soil may account at least in part for the reduced yields secured from the heavily watered plots.

Influence of Amount of Water Applied on Sugar Content.

On four different dates, August 21, August 29, September 12 and September 23, 1933, representative melons from each plot were graded and sugar determinations made according to the Brix method described by Chace, Church and Denny (*2*). Melons were classified as "full slip", in which the fruit dropped off readily from the vine with a clean fracture; "half slip", in which the fruit separated cleanly from the stem on one side

but made a ragged tear on the other; or "non-slip", in which the fruit would not separate from the stem at any point without tearing. The summary of all tests made is given in Table 6. This table shows the number of melons tested in each class and the average Brix reading for each test.

TABLE 6.—RELATION OF IRRIGATION TO SUGAR CONTENT OF CANTALOUPES

Water applied	Full slip		Half slip		Non slip		Total melons	Average brix
	Number	Brix	Number	Brix	Number	Brix		
inches								
½	17	12.67	6	12.32	12	11.39	35	12.19
1	15	12.33	4	11.13	7	10.87	26	11.75
1½	13	12.62	5	10.06	9	11.60	27	11.81
2	27	12.40	6	11.24	7	10.36	40	11.87
Total melons	72		21		35		128	
Average brix		12.49		11.25		11.13		11.91

While the total numbers tested are too small to draw definite conclusions, it would appear that there was very little difference, if any, in sugar content of cantaloupes picked at the same stage of maturity from plots which received different amounts of irrigation water. On the other hand cantaloupes from all plots showed a marked increase in sugar content as they approached full maturity.

Influence of Interval Between Irrigations on Yield and Grade

In the experiments just described, the interval of application was kept constant, but the amounts of water applied were varied. To secure further information on the water requirements of cantaloupes, an experiment was conducted in 1934 in which the same total amount of water was applied to each plot but the intervals between applications were varied. A block of land the same size and shape was laid out in the same manner as in the preceding experiments. The procedure was the same except that three plots received ¾ inch of water each week for 12 weeks; three plots received 1½ inches once every two weeks; and three plots received an application of approximately 2 inches once every 3 weeks. A total of 9 inches was applied to each plot during the season. A summary of the average number of melons per row, the average number of high grade melons, and the average number of slickers per row is shown in Table 7. These results indicate a slight increase in yield from the application of water in small amounts at frequent intervals.

TABLE 7.—EFFECT OF INTERVAL BETWEEN IRRIGATIONS ON YIELD AND GRADE

Length of interval	Average number of melons per row	Average number of grades 36 and 45 per row	Average number of slickers per row
weeks			
1	293	207	3.9
2	283	200	3.3
3	274	192	2.5

SUMMARY

1. Cantaloupe irrigation experiments conducted over a period of three years are described.

2. Physical analyses of soil were made before starting the tests.

3. Different amounts of water were applied at regular intervals, all water being carefully measured.

4. Weekly applications of ½ inch per week gave the greatest total yields, the largest number of high grade cantaloupes, and the smallest number of slickers in all three years.

5. Increase in the amount of water applied in successive years resulted in decreased yield from the same row, and vice versa.

6. Soil moisture determinations made before and after each irrigation showed a tendency for yields to decrease as the amount of water retained in the soil and used by the plants increased.

7. Chemical analyses of soil suggested that leaching of nitrogen from the upper soil layer may have been responsible at least in part for the reduction in yields from the heavily irrigated plots.

8. No significant difference was noted in sugar content of cantaloupes picked at the same stage of maturity from heavily watered as contrasted with lightly watered plots.

9. Regular irrigations in small weekly amounts gave slightly larger yields than the same total amount of water applied in larger amounts at longer intervals.

ACKNOWLEDGMENT

Acknowledgment is due to Mr. R. C. Palmer, Superintendent, Summerland Experimental Station, who contributed helpful suggestions throughout the course of the experiments and edited the manuscript; to Dr. H. R. McLarty, Pathologist-in-charge, Summerland Laboratory of Plant Pathology, who offered constructive criticism of methods of procedure; to Mr. C. C. Kelley, Officer-in-charge of Soil Survey, Kelowna, who made physical analyses of the soil; to Mr. C. A. Hornby, University of B.C., who made chemical analyses of soil; and to Mr. J. E. Britton, Assistant Superintendent, Summerland Experimental Station, who took the photograph.

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Résumé

L'irrigation des cantaloups. W. M. Fleming, Station expérimentale fédérale, Summerland, C.-B.

Cet article est un compte rendu d'essais d'irrigation de cantaloups conduits pendant une période de trois années. Ces essais ont été précédés d'une analyse physique du sol. Différentes quantités d'eau, toutes soigneusement mesurées, ont été appliquées à intervalles réguliers. Les applications hebdomadaires de un demi-pouce par semaine sont celles qui ont donné le plus gros rendement total, le plus grand nombre de cantaloups de choix et le plus petit nombre d'avortons pendant ces trois années. Lorsque la quantité d'eau a été augmentée pendant les années suivantes, la production obtenue sur la même rangée a diminué, et vice versa. Une détermination de l'humidité du sol, avant et après chaque irrigation, a fait voir que les rendements avaient une tendance à diminuer à mesure que la quantité d'eau retenue dans le sol et utilisée par les plantes augmentait. L'analyse chimique du sol porte à croire que le lessivage de l'azote de la couche supérieure du sol peut avoir été, jusqu'à un certain point, la cause de la diminution des rendements sur les parcelles abondamment irriguées. Aucune différence significative n'a été notée dans la teneur en sucre des cantaloups cueillis à la même phase de maturité, sur les parcelles abondamment ou légèrement arrosées. Des irrigations régulières en petites quantités hebdomadaires ont produit des rendements un peu plus forts que la même quantité totale d'eau appliquée à intervalles plus espacés et en quantités plus petites à la fois.

APRICOT THINNING INVESTIGATIONS[1]

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[Received for publication June 30, 1936]

Thinning, or removal of a portion of the crop with a view to increasing the size and grade of the remainder, has become a commercial practice in many apricot orchards of the Pacific Northwest. A search of the literature, however, has failed to reveal any reliable experimental evidence concerning the economy of thinning the apricot crop, the distance to which the fruit should be thinned, or the time when the operation can most advantageously be performed. As apricots are grown commercially in the Okanagan Valley of British Columbia, and many growers practise some thinning of the crop, it was considered advisable to conduct experiments to secure accurate information on this subject. Accordingly, the experiments reported in this paper were conducted at the Summerland Experimental Station in 1934 and 1935.

PRESENTATION OF DATA

The procedure followed and data secured may be conveniently presented under six headings, dealing respectively with the effects of distance of thinning, cluster thinning, leaves per fruit, position of fruit on the tree, rate of ripening, and time of thinning.

Effect of Distance of Thinning on Size and Yield of Apricots

A study was made of different degrees of thinning on size of fruit and amount of crop. Two degrees of thinning were compared: spacing the fruit 2 inches and 4 inches apart, with unthinned trees to act as checks. The varieties under experiment were Wenatchee Moorpark, Tilton, and Blenheim. The trees were selected in groups of threes to conform with the thinning tests outlined above. They were 10 years of age and in excellent condition having received uniformly good cultural treatment since planting.

Thinning was performed just after the June drop when the apricots were slightly over an inch in diameter. At picking time the fruit was sorted according to government grading regulations into No. 1, No. 2, and culls. No. 1 fruit consists of apricots over $1\frac{5}{8}$ inches in diameter, free from blemishes. No. 2 fruit ranges between $1\frac{1}{4}$ and $1\frac{5}{8}$ inches in diameter and must be reasonably free from blemishes. Fruit badly deformed by injury, and fruit below $1\frac{1}{4}$ inches in diameter, is classed as culls. Table 1 indicates the distribution of the crop according to grade.

While there is some lack of uniformity in the results secured, it is evident that the percentage of No. 1 grade fruit was not very materially influenced by the thinning treatments applied. With the exception of the Blenheim variety, the unthinned trees gave as good a percentage of No. 1 fruit as the thinned trees. The unthinned Blenheim tree lacked somewhat in vigour which may account in part for the fact that it yielded only 43% of No. 1 fruit.

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[1] Contribution from the Division of Horticulture, Experimental Farms Branch.

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TABLE 1.—INFLUENCE OF THINNING ON YIELD AND GRADE

Tree No.	Distance of thinning	Percentage fruit in each grade			Total yield
		No. 1	No. 2	Culls	
	inches	%	%	%	lb.
Moorpark					
4456	4	87	13	–	120
4454	2	83	16	1	195
4457	unthinned	68	32	–	155
Tilton					
4370	4	79	21	–	85
4366	2	73	25	2	107
4368	unthinned	78	21	1	167
Tilton					
4474	4	60	38	2	150
4473	2	53	45	2	197
4476	unthinned	79	20	1	281
Blenheim					
4445	4	92	8	–	75
4464	2	90	9	1	125
4356	unthinned	43	57	–	255

FIGURE 1. An unthinned cluster of Blenheim apricots.

The amount of cull fruit was not materially influenced by degree of thinning. The results presented in Table 1 show that both 4 and 2 inch thinning reduced the amount of crop materially without producing any marked improvement in the percentage of No. 1 fruit harvested. In fact,

unthinned Tilton and Blenheim trees produced roughly twice as much fruit as those thinned 4 inches, and more than one and a half times as much as those thinned 2 inches.

Effect of Thinning Clusters on Size and Yield of Apricots

In light bearing years, apricot trees have a tendency to set heavily in clusters in the upper part of the tree. An experiment was undertaken to ascertain the effect of thinning out these heavily set clusters in the Blenheim and Royal varieties. The trees were in excellent condition and carried only a light crop which was concentrated in the upper branches on new wood growth. At thinning time adjacent pairs of clusters were selected and tagged, one cluster being thinned to 3 inches and the other left unthinned. Record was taken of the number of fruits removed and the number left on the thinned branches. At harvest time the numbers of apricots removed from both thinned and unthinned clusters were noted, and the size and grade of the fruit recorded.

In Table 2 it is interesting to note the number of fruits removed in relation to the number allowed to remain on the thinned clusters. In a group of nine Blenheim clusters, 299 out of 415 fruits were removed, or a loss of 72%; similarly, in a group of seven clusters of the Royal variety there was a loss of 79%.

Table 2.—Influence of thinning clusters on percentage fruits removed, and size and grade of fruit at harvest

No. of cluster pairs	No. of fruits on clusters		Average weight of fruit		Percentage of No. 1 fruit	
	Before thinning	After thinning	Thinned clusters lb.	Unthinned clusters lb.	Thinned clusters %	Unthinned clusters %
Blenheim						
9	415	116	.0768	.0722	82	57
Loss of fruit by thinning, 72%.						
Royal						
7	369	79	.0776	.0725	70	56
Loss of fruit by thinning, 79%.						

The increase in size of fruit of both varieties as a result of thinning was remarkably small, the Blenheim increasing from .0722 to .0768 pound, and the Royal from .0725 to .0776, almost an identical amount. The net result of this thinning was to increase the size of the thinned apricots from approximately .072 to .077 pound each or a gain of 6.4%. That is, by thinning out 72 to 79% of the fruit in these clusters, a gain in fruit size of 6.4% was secured. Even allowing for the increase in percentage of No. 1 fruit on thinned clusters, the results indicate that thinning out clusters of apricots on light bearing trees was not only a waste of time, but resulted in a tremendous loss of tonnage.

Effect of Number of Leaves per Fruit on Size of Apricots.

A thinning experiment spacing the fruits according to the number of leaves per apricot was carried out using a 16-year-old tree of the Royal variety. One entire branch was completely defoliated and the fruits on it spaced 4 inches apart. Other limbs were thinned so as to give spacings of 2, 6, 10, 14, 18 and 22 leaves per apricot. Table 3 gives a summary of the results secured.

TABLE 3.—INFLUENCE OF NUMBER OF LEAVES PER FRUIT ON SIZE OF ROYAL APRICOTS

Treatment (leaves per fruit)	Maturity of fruit at picking	Average weight 50 apricots	Average diameter 50 apricots
		lb.	ins.
0	Hard and green	(not picked)	1.16
10 days later	Firm ripe	.043	1.37
2	Green, some firm ripe	.050	1.39
6	Firm ripe, some greenish	.050	1.40
10	Firm ripe to dead ripe	.056	1.47
14	Firm ripe	.054	1.44
18	Firm ripe	.056	1.45
22	Green to firm ripe	.054	1.44

The data indicate that size of fruit increased until a maximum of 10 leaves per apricot was reached. Over 10 leaves per fruit, the size of the apricots remained the same, suggesting that there is a maximum size which apricots will attain irrespective of any increase in leaf surface per fruit.

On the branch which was completely defoliated, the apricots were small and green at the time the rest of the fruit was picked, so they were allowed to remain on the tree to see how much they would increase in size. Ten days later they were picked and were found to have increased in diameter from 1.16 to 1.37 inches. Apparently the chief adverse effect that defoliation had upon this branch was to retard the maturity of the fruit by 10 days. The important thing to note about this defoliated branch is that it demonstrated the ability of the apricot tree to translocate food materials very effectively from one part of the tree to another. The defoliated branch was 5 feet in length, carrying 65 fruits, and yet the fruits on the farthest tip of the branch were equal in size to those near the trunk of the tree. Furthermore, it was observed that apricots located on leafless spurs attained as large size as fruits situated immediately adjacent to leaves in the same part of the tree.

Effect of Position on Size and Grade of Apricots

When picking the various trees it was noted that fruits on upper branches exposed to the sunlight appeared to be of greater size than fruits located on lower shaded branches. Thinned fruits from lower shaded branches were compared with unthinned fruits from upper exposed branches. In each case the average dimensions of 50 apricots were obtained. The data are compiled in Table 4.

TABLE 4.—INFLUENCE OF POSITION ON SIZE AND GRADE OF APRICOTS

Variety	Tree No.	Fruits from lower, shaded branches, thinned		Fruits from upper exposed branches, unthinned	
		Average diameter 50 fruits	Average weight 50 fruits	Average diameter 50 fruits	Average weight 50 fruits
		ins.	lb.	ins.	lb.
Blenheim	1372	1.31	.042	1.50	.062
Blenheim	1346	1.29	.038	1.39	.048
Royal	1602	1.29	.038	1.40	.048

These data show that the position of the fruits on the tree determined, in large measure, the size the fruits attained. Thinned fruits from lower shaded branches attained a size of from 1.29 to 1.31 inches, whereas unthinned fruits from upper branches reached a size of from 1.39 to 1.50 inches. It would appear, therefore, that size of fruit was determined by position on the tree far more than by any thinning treatment which was applied.

Effect of Thinning on Rate of Ripening

The effect of different degrees of thinning on rate of ripening was studied in connection with the trees reported upon in Table 1. Trees of three varieties were thinned 2 inches, 4 inches, and check trees left unthinned. A number of pickings were made, only fruit which was firm ripe and showing full commercial picking maturity being harvested at each picking. Fruit less mature was left on the tree to colour and increase in size until a later picking. Table 5 indicates the results secured.

Table 5.—Influence of thinning on rate of ripening

Tree No.	Distance of thinning	Percentage total crop picked				Total crop
		Aug. 2	Aug. 5	Aug. 10	Aug. 17	
	inches	%	%	%	%	lb.
Moorpark						
4456	4	—	100	—	—	120
4454	2	—	100	—	—	195
4457	unthinned	—	100	—	—	155
Tilton						
4370	4	—	100	—	—	85
4366	2	—	61	39	—	107
4368	unthinned	—	—	67	33	167
Tilton						
4474	4	—	93	7	—	150
4473	2	—	86	14	—	197
4476	unthinned	—	33	44	23	281
Blenheim						
4445	4	53	47	—	—	75
4464	2	—	100	—	—	125
4356	unthinned	—	29	55	16	255

It is evident that the Blenheim and Tilton varieties tended to mature their crop unevenly. The uniformity of maturity on the fruits on 4-inch thinned trees was very noticeable in contrast to unthinned trees, and the effect of 2-inch thinning and no thinning upon delaying the maturity of these varieties is well illustrated. This practice of mak ng several pickings and allowing green fruits to mature, not only resulted in a uniform product, but also resulted in a considerable increase in tonnage of fruit. From the standpoint of returns to the grower, there is seldom any serious disadvantage in late picked apricots, since apricots are usually all handled in one season pool.

Effect of Date of Thinning on Size of Apricots at Maturity

The question arises as to what is the best time to thin apricots to secure maximum size, and what effect delayed thinning has upon date of maturity of the crop. The trees employed in this experiment were 18 years of age, and consisted of 4 Blenheims, 3 Royals, 2 Moorparks, and 1 Tilton. These trees were thinned on seven different dates. The plan followed was to thin one branch on each tree on each thinning date, tagging the limb and recording the size and amount of fruit removed from it. This method had the advantage of eliminating error due to soil variability or tree individuality which is bound to exist where separate trees are compared with each other. Unthinned branches were left on each tree to serve as checks for purposes of comparison with thinned branches. The fruit was thinned to a distance of 4 inches in every instance. At harvest each branch on each tree was picked separately, and a record made of the diameter and weight of 50 fruits.

The data in Table 6 show little beneficial effect resulting from early as opposed to late thinning. While there appears to be a slight tendency for later picked fruit to be smaller at maturity than early thinned fruit,

TABLE 6.—INFLUENCE OF DATE OF THINNING ON DIAMETER AT MATURITY

Variety	Tree No.	Diameter in inches at maturity of fruits thinned on different dates							
		May 3	May 10	May 17	May 25	May 31	June 7	June 28	Unthinned
		in.	in.	in.	in.	in.	in.	in.	in.
Moorpark	1364	1.62	1.59	1.61	1.60	1.65	1.62	—	1.58
	1365	1.64	1.63	1.57	1.64	1.58	1.66	—	1.59
Blenheim	1346	1.40	1.37	1.41	1.40	1.42	1.47	1.38	1.39
	1347	1.58	1.53	1.55	1.48	1.48	1.40	1.31	1.35
	1370	1.37	1.47	1.43	1.51	1.40	1.45	1.39	1.44
	1372	1.43	1.53	1.48	1.57	1.53	1.52	1.46	1.45
Royal	1596	1.49	1.40	1.47	1.47	1.51	1.48	1.47	1.43
	1603	1.45	1.50	1.52	1.50	1.56	1.47	1.44	1.40
Tilton	1607	1.48	1.48	1.47	1.41	1.47	1.41	1.39	1.30

this tendency does not hold throughout, for in several instances, the apricots from unthinned branches were larger in size than those on many of the thinned branches. The fact that unthinned fruit sized almost equally as well as the thinned fruit in all four varieties, suggests strongly that size of fruit is determined largely by factors other than degree of thinning and time at which the thinning operation is performed. To what extent the comparatively large size of the unthinned fruit may be attributed to cross-transfer of food materials from adjacent thinned branches is difficult to estimate. Evidence presented elsewhere in this report, however, indicates cross-transfer of food materials can take place to a marked degree in the apricot tree. With regard to the rate of maturity of apricots from branches thinned on different dates, it was found that only fruit thinned later than three weeks before picking time showed delayed maturity in comparison with the rest of the tree. The same was also true of fruit on unthinned

branches. In the first case the delay in maturity of the fruit was three or four days beyond that of the rest of the crop, and in the second case, still somewhat longer.

SUMMARY OF RESULTS

1. Thinning apricots to 2 inches and 4 inches apart resulted in a slight increase in size in comparison with unthinned checks. However, unthinned trees produced approximately twice as much as trees thinned 4 inches, and approximately one and a half times as much as trees thinned 2 inches.

2. Thinning out clusters of fruit on light crop trees resulted in very little increase in size of fruit. Furthermore, unthinned clusters produced from two to three times the yield produced by those which were thinned.

3. Thinning apricots to more than 10 leaves per fruit did not result in any fruther increase in size of fruit at maturity.

4. The position of apricots on the tree seemed to be the most important factor determining their size. Those fruits on upper exposed branches grew larger whether thinned or unthinned than fruits on the same tree occurring on lower shaded branches.

5. Thinned trees matured their crop fairly evenly but unthinned trees matured their crop over quite a long period. As a result, it was necessary to make several pickings on unthinned trees extending 12 days beyond the time the bulk of the crop was harvested from thinned trees.

6. Time of thinning exerted very little influence on size of fruit, but very late thinning caused some delay in maturity.

7. The evidence secured from these experiments suggests that thinning of apricots is a laborious and ineffective method of securing high grade fruit. Furthermore, the results indicate that heavy yields of high quality apricots can be secured without resort to thinning, provided adequate attention is paid to pruning, maintenance of soil fertility, and harvesting practice.

ACKNOWLEDGMENT

Acknowledgment is due to Mr. R. C. Palmer, Superintendent of the Summerland Experimental Station, who offered helpful suggestions throughout the course of the experiments, and edited the manuscript, and to Mr. J. E. Britton who took the photograph.

Résumé

Recherches sur l'éclaircissage des abricots. D. V. Fisher, Station expérimentale fédérale, Summerland, C.-B.

L'éclaircissage des abricots, pratiqué à deux pouces et à quatre pouces d'espacement, a provoqué une légère augmentation dans la grosseur des fruits, par comparaison aux arbres non éclaircis. D'autre part, les arbres non éclaircis ont produit environ deux fois autant de fruits que les arbres éclaircis à quatre pouces, et environ une fois et demie autant que les arbres éclaircis à deux pouces. L'éclaircissage des grappes de fruits sur les arbres portant une faible récolte n'a provoqué qu'une très faible augmentation dans la grosseur des fruits. En outre, les grappes non éclaircies ont donné un rendement de deux à trois fois plus élevé que celles qui étaient éclaircies.

L'éclaircissage des abricots à plus de dix feuilles par fruit n'a provoqué aucune augmentation dans la grosseur des fruits à la maturité. Le facteur qui paraît être le plus important au point de vue de la détermination de la grosseur est la position des abricots sur l'arbre. Les fruits sur les branches supérieures et exposées, éclaircis ou non, sont devenus plus gros que les fruits qui se trouvaient sur les branches inférieures ombragées du même arbre. Les arbres éclaircis ont mûri leur récolte d'une façon assez égale, tandis que la maturation sur les arbres non éclaircis a été répartie sur une période très longue, ce qui a obligé à faire plusieurs cueillettes sur ces derniers, prolongeant ainsi la durée de la cueillette d'au moins douze jours au-delà du temps où le plus gros de la récolte a été cueilli sur les arbres éclaircis. L'époque de l'éclaircissage n'a exercé que très peu d'effet sur la grosseur des fruits, mais l'éclaircissage pratiqué très tard a retardé quelque peu la maturation. Les résultats de ces expériences indiquent que l'éclaircissage des abricots est un moyen laborieux et peu efficace d'obtenir des fruits de haute qualité. Ils indiquent également que l'on peut obtenir de fortes récoltes d'abricots de choix sans avoir recours à l'éclaircissage, à condition de donner toute l'attention voulue à la taille, au maintien de la fertilité du sol et à la pratique de la cueillette.

SOLUBILITY AND DISTRIBUTION OF PHOSPHORUS IN ALBERTA SOILS[1]

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[Received for publication June 20, 1936]

Phosphorus occurs in the soil in organic and inorganic combination. There is a great difference in the solubility of many of these compounds. The present investigation was undertaken to obtain information regarding the solubility and vertical distribution of the phosphorus compounds in certain typical Alberta soils.

Various methods have been developed for the estimation of easily soluble phosphorus in the soil. However, any proposed method is as yet more or less arbitrary since there still is considerable controversy as to what constitutes the easily soluble phosphorus. The problem is further complicated by the fact that the easily soluble and difficultly soluble phosphorus compounds are not sharply distinct.

The solubility of the soil phosphates is to a large extent dependent on the acidity of the extracting solution (*1*, *4*, *11*). However the amount dissolved by any extractant depends on the inherent characteristics of soils, and in many cases complete solubility of soil phosphorus cannot be brought about by acid extraction.

In the extraction of the easily soluble phosphorus the acidity of the solvent usually decreases somewhat during the extraction process due to the solution of bases, while in the case of plant feeding the solvent (carbonic acid) is continually being replenished by the excretion of additional CO_2 by the roots (*12*). Thus it is important to have the pH of the extractant so adjusted that it will remain the same during the course of extraction in order to get a proper conception of the amount of phosphorus soluble at that pH (*4*). Lohse and Ruhnke (*7*) suggest the use of $KHSO_4$ as solvent claiming a much easier control of pH.

Numerous investigations deal with the distribution of the total amount of phosphorus in different horizons of soils. However the total analysis gives very little information concerning the nature of the soil phosphates in the various horizons. Some investigators found considerable amounts of easily soluble phosphorus in the lower horizons, but there is very little information in the literature concerning any direct attempts at determining the difficultly soluble or organic phosphorus in the lower horizons.

EXPERIMENTAL

The following experiments were designed to obtain evidence on the relative proportions of easily soluble, difficultly soluble and organic phosphorus found in different horizons of typical Alberta soils. The samples used were representative of the more mature profiles of the gray wooded, the black parkland, and the brown prairie soils of Alberta (*5*, *6*, *14*).

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[1] Part of a thesis submitted to the University of Alberta in partial fulfilment for the requirements for the degree of Master of Science.

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For the purposes of this investigation it seemed most logical to separate the easily soluble from the difficultly soluble phosphorus on the basis of iron solubility, since most investigators consider that iron phosphate is difficultly soluble (*1*, *4*, *11*, *12*). In most soils the easily soluble phosphate occurs chiefly as calcium phosphate while the difficultly soluble occur largely as basic ferric phosphates (*12*).

The results of preliminary studies showed a much smaller amount of phosphorus and iron soluble at pH 3 than at pH 2. No iron was found in the extracts of the brown and black profiles at pH 3 and only slight traces in the horizons below the upper B_1 of the gray profiles; while in some cases as much as 160 p.p.m. of iron was dissolved at pH 2. Thus, although H_2SO_4 at pH 2 dissolved the phosphorus more rapidly than did the less concentrated solutions, it seemed unsatisfactory for separating the easily soluble from the difficultly soluble soil phosphorus since at pH 2 considerable amounts of iron were dissolved. The results further show that one extraction was not sufficient to remove all the easily soluble phosphorus. Repeated extractions were necessary.

In all subsequent determinations of the easily soluble phosphorus the acidity of the extracts was maintained at pH 3 $\pm$ .2 by the addition of 1N H_2SO_4 to neutralize the excess bases in samples of certain horizons. Such additions were required in only the first extracts of these samples.

Preliminary investigations dealing with the solvent for difficultly soluble phosphorus indicated that it should be of such concentration that a large amount of inorganic and the smallest possible amount of organic phosphorus would be dissolved. Several concentrations of acid were tried and the amounts of organic and inorganic phosphorus dissolved were determined. Increases in concentration up to 2N resulted in proportionate increases in the amount of phosphorus dissolved. However in concentrations greater than 2N the increases in organic phosphorus dissolved seemed so much greater than the increases in inorganic phosphorus that the use of a solvent of greater concentration than 2N H_2SO_4 was unwarranted. Further study using $KMnO_4$ to determine the amount of organic matter in solution, showed a narrower P : OM ratio in the 2N extracts than in those of greater concentration.

The 2N extracts were too acidic for a direct colorimetric determination of phosphorus. They were adjusted to pH 3 with a predetermined amount of 1–1 NH_4OH. The ammonium salts formed on neutralization interfered with the development and stability of the molybdenum blue colour. However by comparing only a few samples at a time with a standard containing an equivalent amount of ammonium salts reliable readings were obtained.

There is no satisfactory direct method for the determination of organic phosphorus in soils. It was believed that ignition at 600° C. for one hour was sufficient to completely destroy the organic matter and yet not materially affect the solubility of the mineral phosphates. Thus after igniting the samples in the muffle furnace at the above temperature for one hour and cooling, they were then repeatedly extracted in the same manner and with the same solvent as the unignited samples. The increase in the amount of phosphorus dissolved after ignition was attributed to organic phosphorus.

METHODS OF ANALYSIS

Sampling. The samples were obtained from natural horizons and after being air dried were ground to pass a 20 mesh sieve.

Reaction. The pH in all cases was determined by means of the quinhydrone electrode.

Total Phosphorus. The total phosphorus was determined colorimetrically (*13*) after fusing the sample with Na_2CO_3 and then extracting with water.

Extraction. One gram samples were shaken one hour with 200 cc. solvent and filtered through a Buchner funnel. After each filtration the filter paper and soil were returned to the shaker bottle, fresh solvent added and extraction repeated till only traces of phosphorus were dissolved.

Extracted Phosphorus. The phosphorus extracted by .002N H_2SO_4 at pH 3 (*12*) and by 2N H_2SO_4 was determined colorimetrically (*13*). In the latter case a suitable aliquot was taken adjusted to pH 3 with 1–1 NH_4OH, and then analysed for phosphorus by comparing with a standard containing an equivalent amount of ammonium salts.

Soluble Iron. The soluble iron was determined by the method outlined in Standard Methods of Water Analysis (*10*).

RESULTS

Easily Soluble Phosphorus

The results obtained on repeated extraction with .002N H_2SO_4 at pH 3, together with total phosphorus and the pH values, are given in Table 1 and show that there was a noticeable difference in the rate of solubility of phosphorus. In the Provost and Beaumont profiles only 5 extractions were required to extract the easily soluble phosphorus while in the Stony Plain, Fallis and Breton, 6 and 7 extractions were needed. Of the total easily soluble phosphorus over 50% was obtained in the first extraction in most cases. However in the upper B_1 horizons of Fallis and Breton profiles the second and third extracts contained about the same amount of phosphorus as did the first.

The proportion of the total phosphorus in the soil which was found to be easily soluble (last column Table 1) was much greater in the lower horizons than in the upper ones. However in the case of the upper B_1 horizon of the gray profiles the amount extracted was smaller than in any of the remaining horizons. The results further indicate that where lime was present (B_2 and C horizons) the amount of easily soluble phosphorus extracted was greatest. Lohse and Ruhnke (*8*) found a similar distribution in various Ontario soils.

No iron was found in the extracts of the brown and black profiles, while in the gray profiles slight traces were found in the extracts of all horizons below the upper B_1.

TABLE 1.—SOIL REACTION, TOTAL PHOSPHORUS AND EASILY SOLUBLE PHOSPHORUS OF ALBERTA SOILS (EXPRESSED AS P.P.M. ON BASIS OF AIR DRY SOIL)

Horizon	Depth in inches	Soil pH	Total* P in soil	Phosphorus in extracts								% of total* P. extracted
				1st	2nd	3rd	4th	5th	6th	7th	Total extracted	
Provost (brown)												
A_1	0–6	7.1	606	73	29	16	10	8	None	None	136	22
B_1	6–12	7.5	547	164	62	24	13	10	None	None	273	50
B_2	18–24	7.9	518	275	65	22	13	11	None	None	386	75
C	40–43	7.2	513	250	56	29	20	8	None	None	363	71
Beaumont (black)												
A_1	0–15	6.5	939	40	34	14	8	None	None	None	96	10
B_1	15–30	7.0	464	97	42	8	3	None	None	None	150	32
B_2	30–36	7.4	603	290	108	41	12	5	None	None	456	76
C	at 54	7.4	509	300	71	26	12	7	None	None	416	82
Stony Plain (black)												
A_1	0–16	7.2	869	198	42	31	31	16	6	4	328	38
A_2	16–24	7.0	575	115	44	30	24	14	5	6	238	41
B_1	24–40	6.9	405	90	40	22	21	15	6	7	201	50
B_1	at 40	7.0	391	120	38	18	15	6	4	None	201	51
B_2	at 72	7.4	491	218	80	38	26	10	4	None	376	77
Fallis (gray)												
A_0	0–2	7.0	1106	166	37	19	12	15	4	None	253	23
A_1	2–4	6.7	709	70	25	15	10	13	6	None	139	20
A_2	4–12	6.2	351	55	26	18	8	8	3	None	118	34
B_1	12–24	6.0	310	16	12	8	5	None	None	None	41	13
B_1	36–60	7.0	383	183	35	12	7	4	None	None	241	63
B_2	at 60	7.6	506	300	63	22	11	6	None	None	402	80
Breton (gray)												
A_0	0–1	6.4	1730	294	55	29	18	25	10	None	431	25
A_1	1–2	6.0	1305	110	53	37	25	26	16	None	267	20
A_2	2–8	6.0	347	23	23	22	7	3	None	None	78	23
B_1	12–24	5.4	325	16	17	16	6	3	None	None	58	18
B_1	24–56	6.9	538	255	54	33	15	10	10	None	377	70
B_2	56–72	7.5	589	283	91	36	17	10	4	None	441	75
B_2	72–78	7.6	591	293	108	37	17	8	5	None	468	79

* Total P. as determined by Na_2CO_3 fusion method.

Difficultly Soluble Phosphorus

The results of repeated extractions with 2N H_2SO_4 are given in Table 2 and show that the phosphorus was dissolved more rapidly with 2N H_2SO_4 than with H_2SO_4 at pH 3 (Table 1). In the brown and black profiles

TABLE 2.—PHOSPHORUS DISSOLVED FROM ALBERTA SOILS BY REPEATED EXTRACTION WITH 2N H_2SO_4 (EXPRESSED AS P.P.M. ON BASIS OF AIR DRY SOIL)

Horizon	p.p.m. P. in extracts					% of total P.	
	1st	2nd	3rd	4th	Total P. extracted	Extracted by 2N H_2SO_4	Increase extracted by 2N over pH 3
Provost (brown)							
A_1	185	15	8	None	208	34	12
B_1	310	15	7	None	332	61	11
B_2	385	17	6	None	408	79	4
C	388	16	6	None	410	80	9
Beaumont (black)							
A_1	125	11	7	None	143	15	5
B_1	185	12	6	None	203	44	12
B_2	505	17	4	None	526	87	11
C	455	22	6	None	483	95	13
Stony Plain (black)							
A_1	370	23	12	8	413	48	10
A_2	255	20	10	9	294	51	10
U. B_1	215	18	11	7	251	62	12
L. B_1	215	19	10	7	251	64	13
B_2	405	17	5	None	427	87	10
Fallis (gray)							
A_0	330	29	15	10	384	35	12
A_1	265	24	15	10	314	44	24
A_2	175	18	9	7	209	60	26
U. B_1	91	21	13	None	125	40	27
L. B_1	275	17	10	None	302	79	16
B_2	380	20	11	None	411	81	1
Breton (gray)							
A_0	530	36	17	8	591	34	9
A_1	610	42	18	11	681	52	32
A_2	145	21	8	8	182	52	29
U. B_1	137	20	12	8	177	54	36
L. B_1	365	18	10	None	393	73	3
U. B_2	455	19	9	None	483	82	7
L. B_2	465	18	9	None	492	83	4

and the A_0, lower B_1 and B_2 horizons of the gray the phosphorus dissolved in the first extraction with 2N H_2SO_4 was virtually the same as the total extracted with H_2SO_4 at pH 3, while significant increases were found in the first extracts of the A_1, A_2, and upper B_1 horizons of the gray profiles. In the subsequent extracts the amounts dissolved were very small and fewer extractions were needed to remove the soluble phosphorus than was the case with the pH 3 extractant (Table 1).

The increase in the amount of phosphorus extracted by 2N H_2SO_4 over the amount extracted at pH 3 (last column Table 2) represents the amount of difficultly soluble phosphorus. This increase was fairly constant

at about 10% in all horizons of the brown soil except the B_2 where only 4% was difficultly soluble. In the Beaumont A_1 only 5% was difficultly soluble, while in all the other black soil samples it represented about 10% of the total phosphorus. In the gray soils, where leaching has been more severe, a gradual increase in the proportion of difficultly soluble phosphorus occurred from the A_0 horizon (10%) to the upper B_1 horizon (30%). In the lower B_1 and the B_2 horizons the amount found was very much smaller, representing from 1 to 15% of the total.

The data (Table 2) further indicate that where an excess of calcium carbonate was present, the amount of difficultly soluble phosphorus was very small.

ORGANIC PHOSPHORUS

The following section deals with a study of the effects of ignition on the solubility of phosphorus and iron in soils. As a result of this study a method is suggested for determining organic phosphorus in soils.

A comparative study was made, in several profiles, of the results of repeated extraction with H_2SO_4 at pH 3 of soils before and after ignition. The data obtained after ignition, together with the increases due to ignition, are given in Table 3. The results show that in the surface horizons there was a pronounced increase in the phosphorus extracted after ignition, the total being about twice as great as the total extracted from the unignited samples. In the subsurface horizons there was no appreciable increase and ignition often resulted in a slight decrease in the amount of phosphorus extracted.

TABLE 3.—EFFECT OF IGNITION AT 600° C. ON THE AMOUNT OF PHOSPHORUS DISSOLVED FROM ALBERTA SOILS BY REPEATED EXTRACTION AT pH 3
(EXPRESSED AS P.P.M. ON BASIS OF AIR DRY SOIL)

Horizon	P. in extracts							% of total P.		
	1st	2nd	3rd	4th	5th	6th	7th	Total extracted	Extracted at pH 3 after ignition	Increase extracted at pH 3 after ignition
Provost (brown)										
A_1	248	58	37	23	18	12	9	405	67	45
B_1	115	61	49	39	30	14	10	318	58	8
B_2	103	79	60	47	31	14	9	343	66	−9
C	148	65	51	31	21	15	10	341	66	−5
Stony Plain (black)										
A_1	430	107	57	32	26	17	11	680	78	40
A_2	200	59	40	26	21	14	10	370	64	23
U. B_1	120	40	30	20	16	12	8	246	61	11
L. B_1	110	33	21	15	10	None	None	189	48	−3
B_2	155	91	57	32	20	15	10	380	77	0
Breton (gray)										
A_0	1243	190	80	50	29	20	11	1623	94	69
A_1	575	152	80	51	35	25	17	935	72	52
A_2	108	37	21	15	10	None	None	191	55	32
U. B_1	68	24	17	14	9	None	None	132	41	23
L. B_1	205	52	35	24	16	13	9	354	66	−4
U. B_2	250	80	52	33	19	17	12	463	79	4
L. B_2	175	154	80	43	22	19	13	506	86	7

In all cases the differences in the amount of phosphorus extracted with the pH 3 extractant before and after ignition were most pronounced in the first extracts (compare Table 1 and Table 3). The amounts dissolved in the subsequent extracts were also higher after ignition and more extractions were needed to remove the soluble phosphorus than in the unignited samples.

The results of a study on the amount of iron dissolved by the pH 3 extractant before and after ignition are given in Table 4 and show that

Table 4.—The soluble iron* in unignited and ignited soils as determined by repeated extraction at pH 3 (expressed as p.p.m. on basis of air dry soil)

Horizon	Unignited	Ignited			
		1st	2nd	3rd	4th
Provost (brown)					
A_1	None	240	80	40	None
B_1	None	440	120	100	100
B_2	Trace	1040	280	80	40
C	Trace	160	None	None	None
Stony Plain (black)					
A_1	None	280	120	80	None
A_2	None	120	None	None	None
U. B_1	None	60	None	None	None
L. B_1	Trace	240	None	None	None
B_2	Trace	240	80	None	None
Breton (gray)					
A_0	None	280	120	120	80
A_1	None	240	160	160	80
A_2	None	60	None	None	None
U. B_1	Trace	90	None	None	None
L. B_1	Trace	320	None	None	None
U. B_2	Trace	320	None	None	None
L. B_2	Trace	360	60	40	None

*Fe means in this paper Fe^{+++}.

after ignition appreciable amounts of iron were dissolved in all cases. The largest amount found was in the most alkaline brown B_2 horizon (pH 7.9). In the upper horizons, and to some extent in the lower, this increase may be due to a liberation of iron held in organic combination. No explanation is offered for the great increase in the lime horizons.

Similarly a comparative study was made between the amounts of phosphorus dissolved by 2N H_2SO_4 before ignition (Table 2) and after ignition (Table 5). Such a comparison shows that after ignition there was a pronounced increase in the amount of phosphorus in the first extracts, especially of the upper horizons. In the subsequent extracts the amounts dissolved were small, being somewhat greater in the second extracts of the ignited samples. Only three extractions were needed, while in some of the unignited samples four extractions were nedeed to remove the soluble phosphorus.

It has been pointed out that igniting the soil affected the rates and amounts of phosphorus dissolved by the two strengths of acid. The 2N H_2SO_4 dissolved greater amounts in the first and often in the second extracts after ignition. When extracted with H_2SO_4 at pH 3 however the amounts

were greater in the first extracts in all except the lime horizons, while in all the subsequent extracts the amounts dissolved were generally greater and more extractions were required to completely remove the soluble phosphorus than before ignition.

TABLE 5.—EFFECT OF IGNITION AT 600° C. ON THE AMOUNT OF PHOSPHORUS DISSOLVED FROM ALBERTA SOILS BY REPEATED EXTRACTION WITH 2N H_2SO_4 (EXPRESSED AS P.P.M. ON BASIS OF AIR DRY SOIL)

Horizon	Phosphorus in extracts				% of total phosphorus	
	1st	2nd	3rd	Total extracted	Extracted by 2N H_2SO_4 after ignition	Increase extracted by 2N H_2SO_4 after ignition
Provost (brown)						
A_1	515	31	11	557	92	58
B_1	485	27	9	521	95	34
B_2	465	23	7	495	96	17
C	460	25	8	493	96	16
Beaumont (black)						
A_1	805	40	10	855	91	76
B_1	335	23	8	366	79	35
B_2	550	23	6	579	96	9
C	495	19	10	524	100	5
Stony Plain (black)						
A_1	740	37	11	788	91	43
A_2	455	30	11	496	86	35
U. B_1	305	21	9	335	83	21
L. B_1	290	23	12	325	83	19
B_2	475	18	10	503	100	13
Fallis (gray)						
A_0	1070	35	11	1116	100	65
A_1	590	36	16	642	91	47
A_2	270	23	9	302	86	26
U. B_1	215	25	8	248	80	40
L. B_1	315	18	5	338	88	9
B_2	485	19	5	509	100	19
Breton (gray)						
A_0	1625	62	9	1696	98	64
A_1	1065	63	13	1141	87	35
A_2	290	20	6	316	91	39
U. B_1	255	25	12	292	90	36
L. B_1	440	21	11	472	88	15
U. B_2	520	19	8	547	93	11
L. B_2	505	19	7	531	90	7

The data of Table 3 show that in the lower horizons at any rate ignition apparently rendered some of the easily soluble phosphorus insoluble in the pH 3 extractant, since in some cases slightly less phosphorus was extracted after ignition than before. However, although ignition has some effect on the solubility of mineral phosphates (2, 3, 9) in H_2SO_4 at pH 3 (Tables 3 and 4) yet the 2N extracts (Table 5) showed no such decrease in the amount dissolved after ignition. Apparently ignition has not materially affected their solubility in 2N H_2SO_4. Thus the increases found in extracting with 2N H_2SO_4 after ignition over the amounts extracted before ignition by this

solvent were believed to more closely approximate the amount of phosphorus occurring in organic combination. Very similar results were obtained when organic phosphorus was determined by difference in only the first extracts, and it would appear that for all practical purposes repeated extractions are not necessary.

On the basis of these results it is suggested that organic phosphorus may be determined in one extraction by the following method. Take two duplicate one gram samples of twenty mesh soil and ignite one set at 600° C. for one hour. Extract both sets with 2N H_2SO_4, and the increase obtained on ignition represents the amount of phosphorus found in organic combination.

It is of interest that a comparative study of the nitrogen and organic phosphorus (by the 2N H_2SO_4 ignition method) of these samples showed a marked uniformity in the phosphorus-nitrogen ratios. In the Provost profile the ratio was, on the average, 1 : 10.6, and in the surface horizons of the remaining profiles it was 1 : 10.4, while in 15 of the remaining 18 subsurface horizons the ratio was 1 : 6.44.

The A_0 horizons of the Fallis and Breton profiles (Table 5) had 65% of their phosphorus in organic combination. In the Beaumont the A_1 had 76%, while in the A_1 of the other profiles the amount varied from 35 to 58%. The A_2 horizons had 35 to 39% as organic phosphorus with the exception of the Fallis (26%). The B_1 of the Provost, Beaumont and Breton, and the upper B_1 of the Fallis had 34 to 40% of the total as organic phosphorus. In the lower horizons of all profiles the amount of phosphorus in organic combination was small; the proportion varying from 5 to 20%.

RELATIVE PROPORTION AND ACTUAL AMOUNT OF EASILY SOLUBLE, DIFFICULTLY SOLUBLE, ORGANIC AND INSOLUBLE PHOSPHORUS IN ALBERTA SOILS

The previous data have been assembled in Table 6 to show the relative proportion and actual amounts of easily soluble, difficultly soluble, organic and insoluble phosphorus in typical Alberta soils.

The results showing the amounts of easily soluble phosphorus are given in column 1, Table 6. They show that in most cases there was an increasing proportion of easily soluble phosphorus of from 10 to 40% in the A horizons to 50 to 80% in the B and C horizons. In the case of the upper B_1 horizons of the gray profiles there was a very low proportion of easily soluble phosphorus. The evidence seems to show that this phosphorus has been removed from these horizons by the plant roots.

The amounts of difficultly soluble phosphorus were fairly constant at about 10% in the Provost, Stony Plain and Beaumont profiles where leaching had not been severe. The amounts were also very small in the lime horizons of the gray profiles. However, in the leached horizons of the gray profiles (Breton and Fallis) the amounts of difficultly soluble phosphorus were markedly greater, being as high as 30% of the total. These results would seem to indicate that in the presence of free lime or in the absence of excessive leaching there is a tendency to retard the formation of difficultly soluble phosphorus.

TABLE 6.—RELATIVE PROPORTIONS AND ACTUAL AMOUNTS OF EASILY SOLUBLE, DIFFICULTLY SOLUBLE, ORGANIC AND INSOLUBLE PHOSPHORUS FOUND IN REPRESENTATIVE PROFILES OF ALBERTA SOILS

Horizon	Easily soluble phosphorus		Difficultly soluble phosphorus		Organic phosphorus		P. insoluble after igniting and extracting with 2N H_2SO_4	
	% of total P.	P.p.m.	% of total P.	P.p.m.	% of total P.	P.p.m.	% of total P.	P.p.m.
Provost (brown)								
A_1	22	136	12	72	58	349	8	49
B_1	50	273	11	59	34	189	5	26
B_2	75	386	4	22	17	87	4	23
C	71	363	9	47	16	83	4	20
Beaumont (black)								
A_1	10	96	5	47	76	712	9	84
B_1	32	150	12	53	35	163	21	98
B_2	76	456	11	70	9	53	4	24
C	82	416	13	67	5	41	0	−15
Stony Plain (black)								
A_1	38	328	10	85	43	375	9	81
A_2	41	238	10	56	35	202	14	79
U. B_1	50	201	12	50	21	84	17	70
L. B_1	51	201	13	50	19	74	17	66
B_2	77	376	10	51	13	76	0	−12
Fallis (gray)								
A_0	23	253	12	131	65	732	0	−10
A_1	20	139	24	175	47	328	9	67
A_2	34	118	26	91	26	93	14	49
U. B_1	13	41	27	84	40	123	20	62
L. B_1	63	241	16	61	9	36	12	45
B_2	80	402	1	9	19	98	0	− 3
Breton (gray)								
A_0	25	431	9	160	64	1105	2	34
A_1	20	267	32	414	35	460	13	164
A_2	23	78	29	104	39	134	9	31
U. B_1	18	58	36	119	36	115	10	33
L. B_1	70	377	3	16	15	79	12	66
U. B_2	75	441	7	42	11	64	7	42
L. B_2	79	468	4	24	7	39	10	60

It will be seen from Table 6 that the organic phosphorus varies both in amounts and percentage of the total with the different profiles. The amounts found in the surface horizons vary from about 350 to 1100 parts per million, whereas the proportion varies from 43 to 76%. Most of the organic phosphorus in the profiles is found in the surface horizons where it generally constitutes a much greater proportion than the easily soluble phosphorus, whereas in the lower horizons the organic phosphorus constitutes a relatively small proportion of the total, most of which is easily soluble.

Under the most severe condition of extraction used, which was igniting and then continuously extracting with 2N H^2SO_4 (Table 6, column 4), all the phosphorus was not extracted in many cases. The amount remaining represented from 0 to 20% of the total.

The data (Table 6) show that in the A_1 horizon of the brown soil the phosphorus was chiefly organic (58%) with smaller proportions of the easily soluble (22%) and difficultly soluble (12%). In the B_2 and C horizons phosphorus occurred chiefly as the easily soluble (75 and 71%) with only small percentages of the organic and difficultly soluble forms.

In the A horizon of the black soil organic phosphorus constituted from 40 to 76% of the total. This, together with the easily soluble phosphorus accounted for at least 80 of the total in these horizons. In the lower horizons the amount of organic phosphorus decreased abruptly while the easily soluble increased proportionately, constituting by far the most important source. The difficultly soluble phosphorus remained about constant (10 to 13%) throughout the entire profile.

The gray soils had in their thin A_0 horizons the largest proportion of the total phosphorus in organic combination, a considerable amount as easily soluble and only a relatively small amount as difficultly soluble. The notable characteristic of these profiles is the comparatively large amounts of difficultly soluble phosphorus in the A_1, A_2, and upper B_1 horizons, constituting in some cases as much as one-third of the total. Below the upper B_1 horizon the easily soluble form was increasingly predominant and the organic and difficultly soluble forms represented decreasingly small amounts.

SUMMARY

The various horizons of typical brown, black, and gray profiles were studied in an effort to determine the solubility and distribution of phosphorus.

Several extractions with either pH 3 or 2N sulphuric acid solution are necessary in order to obtain the total phosphorus soluble in these solvents. Repeated extractions also show the rate of solubility.

In determining the vertical distribution of easily soluble soil phosphorus, extraction at the same pH value in the extracts from all horizons was necessary. In the extractions of calcareous B_2 and C horizons, additional amounts of acid were required in the extractant in order to maintain the desired pH.

Easily soluble phosphorus was determined by extractions with sulphuric acid at pH 3, difficultly soluble as the difference between the amount extracted with pH 3 and 2N sulphuric acid, and organic phosphorus as the difference extracted with 2N sulphuric acid before and after ignition.

Easily soluble phosphorus was found to be present in much larger quantities in the B_1, B_2, and C horizons of the brown profile than in the A_1 horizon. In the black profiles it was present in small to medium amounts in the A and B_1 horizons, and increased to form a large percentage of the total phosphorus in the B_2 or lime horizon. The gray profiles had a medium proportion of easily soluble phosphorus in their A_0, A_1, and A_2, a small amount in the upper B_1, and then decidedly large amounts in the lower B_1, upper B_2 and lower B_2 horizons.

Difficultly soluble phosphorus was found to be fairly low in all horizons of the brown and black soils. The gray profiles showed a small proportion of difficultly soluble phosphorus in the A_0 horizon, much greater proportions in the A_1, A_2, and upper B_1 horizons, and small proportions

below the upper B_1 horizon. The A_1, A_2, and upper B_1 horizons of the gray soils were with one exception the only ones in this investigation that had a greater proportion of difficultly soluble than of easily soluble phosphorus.

Organic phosphorus occurred in large amounts in the surface horizons, but below these the quantities of organic phosphorus diminished to very small amounts in the B_2 and C horizons.

Amounts of phosphorus varying from 0 to 20% remained insoluble after igniting and repeatedly extracting with 2N sulphuric acid.

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Résumé

Solubilité et distribution du phosphore dans les sols de l'Alberta. W. K. Odynski, Université de l'Alberta, Edmonton, Alberta.

Il a été fait une étude des différents horizons de profils typiques bruns, noirs et gris, pour essayer de déterminer la solubilité et la répartition du phosphore. Il est nécessaire de faire plusieurs extractions au moyen du pH3 ou d'une solution d'acide sulfurique 2N pour obtenir la quantité totale de phosphore soluble dans ces dissolvents. Ces extractions répétées indiquent également la rapidité de la solubilité. En déterminant la distribution verticale du phosphore aisément soluble il a été nécessaire de faire l'extraction à la même valeur de pH dans les extraits de tous les horizons. Dans les extractions des horizons calcaires B2 et C il a fallu ajouter une quantité supplémentaire d'acide à la solution pour maintenir le pH désiré. La quantité de phosphore aisément soluble a été déterminée par des extractions à l'acide sulfurique au pH3; la quantité malaisément soluble était la différence entre la quantité extraite au moyen du pH3 et celle extraite au moyen de l'acide sulfurique 2N, et le

phosphore organique, la différence extraite au moyen de l'acide sulfurique 2N avant et après l'incinération. Le phosphore aisément soluble a été trouvé en quantité beaucoup plus grande dans les horizons B1, B2, et C du profil brun que dans l'horizon A. Dans les profils noirs, il était présent en quantités de faibles à moyennes dans les horizons A et B1, tandis qu'il formait une forte proportion du phosphore total dans l'horizon B2 ou calcaire. Les profils gris avaient une proportion médiocre de phosphore aisément soluble dans les horizons Ao, A1 et A2, une petite quantité dans l'horizon supérieur B1 et des quantités beaucoup plus fortes dans les horizons inférieur B1, supérieur B2 et inférieur B2. Le phosphore malaisément soluble n'a été trouvé qu'en quantités assez faibles dans tous les horizons des sols bruns et noirs. Les profils gris accusaient une petite proportion de phosphore peu soluble dans l'horizon Ao, des proportions beaucoup plus fortes dans les horizons A1, A2 et supérieur B1, et de petites proportions au-dessous de l'horizon supérieur B1. Les horizons A1, A2 et supérieur B1 des sols gris étaient, sauf une exception, les seuls dans cette enquête qui contenaient une plus grande proportion de phosphore difficilement soluble que de phosphore aisément soluble. Le phosphore organique était présent en grandes quantités dans les horizons de surface, mais au-dessous de ces horizons les quantités de phosphore organique n'étaient plus qu'en très petites quantités dans les horizons B2 et C. Les quantités de phosphore variant de 0 à 20 sont restées solubles après l'incinération et l'extraction répétée avec l'acide sulfurique 2N.

THE ECONOMIC ANNALIST

A REVIEW OF AGRICULTURAL BUSINESS PREPARED BI-MONTHLY BY THE AGRICULTURAL ECONOMICS BRANCH, DEPARTMENT OF AGRICULTURE, OTTAWA

Vol. VI, No. 6 August, 1936

THE ECONOMIC SITUATION

PREPARED IN THE AGRICULTURAL ECONOMICS BRANCH, DEPARTMENT OF AGRICULTURE, OTTAWA, LARGELY FROM BASIC DATA COLLECTED BY THE DOMINION BUREAU OF STATISTICS

THE ECONOMIC SITUATION

Prices during the first six months of 1936 recorded moderate gains over the same period of 1935. The index of wholesale prices of all commodities increased from 72.0 for the first half of 1935 to 72.4 for the first half of 1936 while the index number of the price of farm products amounted to 62.7 and 63.5, respectively, for the two periods. Retail prices and cost of services increased from an index of 78.8 for the first period to 80.2 for the latter.

During the depression while prices of farm products declined precipitously, retail prices and cost of services showed a marked resistance to any change. In February, 1933, when a low was recorded for primary products, the price of farm products was represented by an index of 43.0 and retail prices and cost of services by an index of 78.4. That is, it took 80 per cent more farm products to pay for a unit of goods at retail than it did in 1926. By June, 1936, the index of the price of farm products had risen to 64.5 while that of retail prices and cost of services stood at 80.0. That is, while prices of farm products registered an increase of 50 per cent, retail prices and cost of services only increased by 2 per cent. While a further rise in farm prices is required to restore the 1926 parity, the increase in the purchasing power of farm products which occurred during the past three years has done much to restore the farming business to a paying basis.

Physical Volume of Business.—Continued improvement of business activity during May is evidenced by a substantial increase in the production indices, not only over the preceding month but also over the same month of last year. The index of the physical volume of business at 109.7 showed an increase of 6.2 per cent in the twelve-month period. In spite of the recession during the first quarter, recent expansion will place the first five months of 1936 almost as high as the last quarter of 1935 which marked the high point of several years. Since as a result of a falling off of the movement of wheat, oats and cattle to market, grain and live stock marketings decreased from an index of 115.8 for April to 110.0 for May, the increase in physical production is wholly attributable to an improvement in industrial production. The most noteworthy gains occurred in manufacturing and crude petroleum imports. Increased activity in private building during the first five months of 1936 indicates a gradual return to normal business conditions. The production figures for June were entered after the above was written and may be referred to for comparison.

Wholesale Prices.—Price movements in May were characterized by declining tendencies in the majority of commodity groups. During June, however, a recovery was experienced, the index number of wholesale prices for the month being 72.3 as compared with 71.8 for May and 71.5 for June, 1935. The principal factor in this change in trend was the recovery in the index of the vegetable products group which occurred as a result of the increase in the prices of wheat and other grains following

ANNUAL AND MONTHLY INDEX NUMBERS OF PRICES AND PRODUCTION COMPUTED BY DOMINION BUREAU OF STATISTICS

Year	Wholesale Prices 1926 = 100				Retail prices and cost of services (5)	Production (6) 1926 = 100			
	All commodities (1)	Farm products (2)	Field products (3)	Animal products (4)		Physical volume of business	Industrial production	Agricultural marketings	Cold Storage holdings
1913	64.0	62.6	56.4	77.0	65.4				
1914	65.5	69.2	64.9	79.0	66.0				
1915	70.4	77.7	76.9	79.2	67.3				
1916	84.3	89.7	88.4	92.3	72.5				
1917	114.3	130.0	134.3	119.6	85.6				
1918	127.4	132.9	132.0	134.7	97.4				
1919	134.0	145.5	142.4	152.5	107.2	71.3	65.5	48.1	47.1
1920	155.9	161.6	166.5	149.9	124.2	75.0	69.9	52.6	94.2
1921	110.0	102.8	100.3	108.5	109.2	66.5	60.4	65.2	86.4
1922	97.3	86.7	81.3	99.1	100.0	79.1	76.9	82.6	82.8
1923	98.0	79.8	73.3	95.1	100.0	85.5	83.8	91.4	87.6
1924	99.4	87.0	82.6	97.2	98.0	84.6	82.4	102.5	114.9
1925	102.6	100.4	98.1	105.7	99.3	90.9	89.7	97.2	108.6
1926	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1927	97.7	102.1	99.9	105.7	98.4	106.1	105.6	103.6	110.0
1928	96.4	100.7	92.6	114.3	98.9	117.3	117.8	146.7	112.8
1929	95.6	100.8	93.8	112.5	99.9	125.5	127.4	101.1	109.6
1930	86.6	82.3	70.0	102.9	99.2	109.5	108.0	103.0	128.4
1931	72.2	56.3	43.6	77.6	89.6	93.5	90.4	99.0	125.7
1932	66.7	48.4	41.1	60.7	81.4	78.7	74.0	114.3	120.1
1933	67.1	51.0	45.8	59.7	77.7	79.7	76.8	105.1	115.4
1934	71.6	59.0	53.8	67.7	78.9	94.2	93.6	88.5	114.2
1935	72.1	63.4	57.1	73.9	79.3	102.4	103.3	87.4	128.4
1935									
Jan.	71.5	61.4	55.7	71.0	78.8	97.5	97.8	30.6	143.7
Feb.	71.9	62.0	55.7	72.6	78.9	100.6	101.1	62.2	141.2
Mar.	72.0	62.7	56.4	73.3	78.8	94.2	93.3	65.4	143.2
Apr.	72.5	64.7	59.8	72.9	78.6	98.3	97.7	91.8	135.8
May	72.3	64.1	58.0	74.4	78.6	103.2	104.4	86.3	123.2
June	71.5	61.4	55.1	72.0	78.8	99.2	99.7	106.1	125.0
July	71.5	61.5	55.7	71.1	78.8	103.0	104.0	164.7	114.8
Aug.	71.6	61.8	55.5	72.4	79.4	107.9	110.3	163.9	117.0
Sept.	72.3	64.7	58.3	76.5	79.6	101.9	102.5	114.2	117.2
Oct.	73.1	65.8	59.3	76.7	80.4	107.2	109.5	86.6	119.7
Nov.	72.7	65.0	57.8	77.1	80.6	110.0	113.5	43.3	127.1
Dec.	72.6	65.4	57.9	77.9	80.6	106.2	108.8	34.0	133.4
1936									
Jan.	72.9	65.9	59.0	77.5	80.7	105.2	107.0	39.8	143.4
Feb.	72.5	66.0	58.9	77.8	80.4	104.9	104.9	62.7	150.3
Mar.	72.4	65.5	59.2	76.0	80.5	103.3	104.1	89.5	149.5
Apr.	72.2	65.0	59.8	73.8	79.8	108.8	109.2	115.8	149.3
May	71.8	64.8	59.9	73.0	80.1	109.7	110.6	110.0	144.5
June	72.3	64.5	60.8	70.7	80.0	110.3	111.6	73.9	171.9

1. See Prices and Price Indexes 1913-1928, pp. 19-21, 270-289 and 1913-1934, p. 15.
2. Wholesale prices of Canadian products of farm origin only. See Prices and Price Indexes 1913-1934, p. 52, and Monthly Mimeographs 1934 and 1935.
3. Wholesale prices of grains, fruits and vegetables.
4. Wholesale prices of Animals and Animal Products.
5. Including foods, rents, fuel, clothing and sundries. See Prices and Price Indexes 1913-1928, pp. 181-185, 290-293. 1926 = 100. Prices and Price Indexes 1913-1934, p. 117, and Monthly Mimeographs, 1934-1935.
6. Monthly Review of Business Statistics, p. 8, and Monthly Indexes of the Physical Volume of Business in Canada, supplement to the Monthly Review of Business Statistics, November, 1932.

reports of adverse weather in some of the more important wheat belts of North America. A substantial increase also occurred in the animal and animal products group index in spite of a violent decline in the prices of hides and skins and of fats.

With the exception of the textile and chemical groups in which heavy losses were sustained, an advance in wholesale prices was recorded in June, 1936, as compared with the same month of the previous year.

Retail Prices.—The index of retail prices, rents and cost of services at 80.0 showed a slight decline as compared with the month previous caused by a decrease in the price of fuel. Slight increases were recorded in most of the constituents making up the index as compared with June, 1935, when the index stood at 78.8.

Prices of Farm Products.—With one of the smallest visible supplies of wheat for several years and reports of crop reduction due to drought, Canadian wheat prices made appreciable gains during June. The price of No. 1 Northern wheat at Winnipeg increased from 75¾ cents on June 1 to 84 cents on June 25, falling to 80⅝ cents at the end of the month as a result of rains. A substantial improvement in prices of the coarse grains also occurred during June. Although cattle markets opened firm, heavy marketings and a decreased demand in the export trade resulted in lower prices during the month. As a result of a reduction in offerings and improved domestic buying, prices again advanced toward the end of the month. Prices for live hogs averaged considerably higher during June than in the month previous. Prices of butter and eggs not only exceeded those obtained in May but also those of June 1935. Cheese prices in June averaged 13.1 cents, almost 3 cents higher than for the same month of 1935. This is the highest point recorded since 1930. Decreases occurred in prices of milk and hides and skins. Recent crop reports state that while northern areas of Manitoba, some eastern and central parts of Saskatchewan and northern districts of Alberta retain fair prospects, a huge grain area has been irreparably damaged and is still deteriorating. Hail losses have been extensive in Saskatchewan and Alberta while grasshoppers are migrating to the better crop areas. Danger of significant rust damage is present in some areas. Rain is urgently needed to arrest declining crop prospects.

Prices in United Kingdom.—The index number of the prices of agricultural produce (1911—13 = 100) was 115 for May as compared with 123 for April and 111 for May 1935. If allowance be made for payments under the Wheat Act, 1932, and the Cattle Industry Act, 1934, the index for May would be 120. Wheat, barley, oats, fat cattle, bacon hogs, eggs and potatoes showed an increase above April price levels. Fat sheep, porkers, butter and milk declined.

The Situation in the United States.—Industrial activity was 19 per cent greater in May 1936 than in May 1935. Construction activity continues to be the weakest part of the domestic demand situation. The money income of consumers has continued to increase and in May reached 82.5 per cent of the 1924–29 average. This is a new high level for the recovery period, representing an increase of nearly 40 per cent from the low point of 1933. Compared with May 1935, consumer income per person, exclusive of income from farm production, was 10 per cent greater and could purchase 12 per cent more in exchange for food and 9 per cent more in exchange for other items in the average industrial worker's budget. The higher volume of consumption of agricultural products for industrial uses and the higher level of consumer purchasing power is maintaining the cash income from the sale of farm products, particularly live stock and live stock products, well above the comparable 1935 returns.

The fourth meeting of the International Conference of Agricultural Economists will be held at St. Andrews, Scotland, August 31st to September 7th. The President, Mr. L. K. Elmhirst, announces that the Conference will concern itself mainly with regard to the following questions: The relations of agriculture to industry and the community; The relation of land tenure to the economic and social development of agriculture; Farm organization with special reference to the needs of the technical, industrial and economic development of agriculture. Others papers dealing with various subjects will also be read.

THE CANADIAN COUNCIL ON BOYS' AND GIRLS' CLUB WORK

The Canadian Council on Boys' and Girls' Club Work was organized in 1931 for the purpose of developing and maintaining a national boys' and girls' farm club policy for the co-ordination of effort, by the unification of the basic principles of club organization and activity and by fostering the development of club work on a sound and constructive basis. The present membership of the Council includes the Dominion Department of Agriculture, all of the Provincial Departments of Agriculture, except that in Saskatchewan, the Extension Department of the University of Saskatchewan being the member representing that province, and several business institutions and associations, including the Canadian National Railways, Canadian Pacific Railway, Industrial and Development Council of Canadian Meat Packers, International Harvester Company of Canada, Limited, North-West Grain Dealers' Association, Canadian Ayrshire Breeders' Association, Canadian Jersey Cattle Club, Canadian Seed Growers' Association, Canadian Swine Breeders' Association, and the Holstein-Friesian Association of Canada. The central office of the Council is located at Ottawa, and the General Secretary is A. E. MacLaurin.

The administration of the Council is financed by grants from the Dominion and Provincial Departments of Agriculture, and the membership subscriptions of the business institutions and associations are devoted to the conduct of annual inter-provincial club contests at the Royal Winter Fair.

Club work for farm boys and girls, which began in Canada about twenty-five years ago, has been gradually developed and improved until it now occupies a prominent position in the agricultural extension programs of all Departments of Agriculture. Club work is designed to develop interest in the farm and farm life, to provide a practical education in agriculture and home economics, to improve farm practices, to encourage the use of better live stock and seed, and to train young people for citizenship in their respective districts.

National, or inter-provincial club contests are conducted annually by the Canadian Council in conjunction with the Royal Winter Fair at Toronto. In 1935 six projects, including dairy cattle, beef cattle, swine, poultry, seed grain and seed potatoes, were included in the contest program, and sixty-four members, or thirty-two teams of two members each, competed, representing every Province in the Dominion.

Five of the annual National Contests have been conducted by the Council since it was formed in 1931. It has been clearly demonstrated that these contests have a very definite and beneficial influence on club activities. The necessary regulations for the contests have a bearing upon the basis of club organization and activity and the oral examinations, which form part of each project contest, encourage greater study of the project in hand by club members. Teams are selected for the contest at Toronto by means of provincial elimination contests conducted on the same general basis as the national event.

In 1935 there were 30,282 members enrolled in 1,900 active boys' and girls' clubs in Canada. The rate of progress in point of numbers enrolled is indicated by comparison with the figures for 1931, when there were 1,215 clubs with 21,142 members.

The Canadian Society of Agricultural Economics held its annual meeting at the University of New Brunswick, Fredericton, N.B., July 14th to 16th. Land settlement, rural population movement, agricultural policy, agricultural economics, curriculae and research were featured in this eighth annual meeting. The officers for the coming year are: President—Dr. T. W. Grindley, Agricultural Branch, Dominion Bureau of Statistics, Ottawa; Vice-President—J. Coke, Economics Branch, Department of Agriculture, Ottawa; Secretary-Treasurer—J. B. Rutherford, Agricultural Branch, Dominion Bureau of Statistics, Ottawa; Committee—Prof. Chas. Gagne, Ste. Anne de la Pocatiere, Quebec, F. W. Reinoehl, Winnipeg, Manitoba, C. W. Riley, Guelph, Ontario and A. Stewart, Edmonton, Alberta.

SOME PROBLEMS IN RURAL APPRAISAL

S. C. HUDSON[1]

The inadequacy of farm appraisal methods has been forcibly demonstrated by the large number of farm mortgage defaults and debt adjustments which have occurred since 1929. While land values were rising, careful appraisal was not particularly important since land values were increasing fast enough to counteract an over-valuation of property. Declining land values, however, have provided an impetus for the development of a sound objective basis for land valuation. Farmers buying farms on a fifty per cent equity or better during the post-war period have recently found their equity to be wiped out and the fruits of a lifetime's labour lost.

Land has value because it produces an income in the form of materials and services that satisfy human wants. This income may be material or psychic or both. It may appear in the form of the products of the soil, the situation factor, or the expected increase in income—the speculative factor. The task which the appraiser is called upon to perform is to determine that income and to express it in terms of a present worth.

Basis of Appraisal.—The most commonly used guide in farm appraisal practice has undoubtedly been sale value. Since sale value reflects the opinion of the multitude of individuals who make up the market, it is considered by many writers to be the best measure of value. In a perfect market, in the case of consumable goods, the market price is undoubtedly the best obtainable measure of value. The necessity of forecasting future income in the valuation of land or capital goods, however, introduces a factor which reduces the accuracy of this market value. A comparison of farm sale values and the prices of farm products indicates that sale values are for the most part based on current earnings, little consideration being given to probable price trends. As a consequence, appraisals for loan purposes based upon sale values cause over-inflation of land values during periods of rising prices due to excessive liberality in lending. During a period of falling prices, on the other hand, land values are deflated and it is impossible for the farmer to obtain sufficient credit to meet his needs. Widespread default must follow.

A perfect market, moreover, implies that the commodity sold is uniform or that there is a complete and accurate knowledge of all differences in it. From this standpoint, the land market cannot be considered a perfect market. Land not only lacks uniformity but the elements of variation are not generally known. In this connection, a study of apple farms in the Newfane-Olcott area of Western New York during the 13-year period 1913–1925 indicates that a farmer might better have paid $292 per acre for the average farm on Dunkirk sandy loam soil rather than have accepted a farm on Clyde fine sandy loam soil as a gift[2]. During this period, farms on Dunkirk sandy loam soil sold at prices approximating $292 per acre while those on Clyde fine sandy loam were valued at $182 per acre. That is, individuals making up the farm real estate market not only failed to consider the longtime price trend but also failed to give sufficient consideration to the relative earning capacity of farms on the different soil types.

One of the principal reforms in appraisal practice within recent years has been a shift from sale value to normal value as a basis of appraisal. In this connection, the United States Federal Farm Loan Act, as amended, requires that the value of land for agricultural purposes shall be the basis of appraisal and that the earning power of the land shall be a principal factor. In arriving at the value of a farm under these provisions, an estimate is made of the average annual yields of crops that the farm would ordinarily produce in the hands of an average farmer, taking into consideration quality of soil, topography, normal rainfall, frequency of sub-normal

[1] Assistant Economist, Economics Branch, Department of Agriculture, Ottawa, Canada.
[2] Scoville, G. P. *et al*, The Apple Situation in New York, Cornell Ext. Bulletin 172, 1928.

precipitation, quality and adequacy of water supply and other related factors. Average unit prices received by farmers during 1909 to 1914 with such adjustments as may be necessary by reason of subsequent changes in the economic position of certain commodities, are applied to the quantity of crops produced in establishing the average annual gross income. The appraiser then determines the net income and by applying a rate of capitalization previously established arrives at the normal value of the farm.

The selection of a base period for the calculation of normal income has been subject to some controversy. Following a thorough research into price trends for the past 135 years, the United States Farm Credit Administration arrived at the conclusion that prices would probably return to approximately the average level which prevailed during the 10-year period 1905–1914. For sake of convenience, the somewhat similar 5-year period 1909–1914 was selected as the standard of normal prices. Other authorities indicate a preference for the use of the preceding 20 years as the base. While such methods of establishing a base period leave much to be desired, they represent at least a movement in the direction of a more scientific procedure and will aid in the obtaining of greater reliability in appraisals until more exact methods of price forecasting are devised. Since such a practice means lending more than prevailing prices justify during periods of low prices and less than prevailing prices justify during periods of high prices, it has a stabilizing effect upon the agricultural industry.

While in most types of farming in Canada, price is the predominant factor causing variation in farm income, there are other instances in which the hazards of production are more important than price variation in causing variability in income. This is particularly true in the production of such cash crops as wheat and tobacco. It is of the utmost importance that, in arriving at the valuation of lands normally used for such crops, cognizance be taken of the exigencies of production.

Appraisal of Individual Farms.—In actual practice appraisers do not ordinarily attempt to value each farm independently but rather engage in what might be termed "relative appraisal". That is, when an appraiser begins work in an area, one or more farms are selected for which a very careful appraisal is made according to the methods outlined above. The valuations of these base farms are then used as a guide in making other appraisals in that region. A somewhat similar method of relative valuation is used by assessors. Although the assessed valuation is not necessarily the same as the actual value, the assessed value of two properties in the same community supposedly bear the same relationship to each other as that existing between their full values. The need for greater care and improved methods in such valuation procedure has been demonstrated by several studies which have indicated that appraisers and assessors tend to over-value poor land and to under-value good land relative to their earning capacity[3]. This is caused by the appraiser placing undue emphasis on certain factors in connection with the individual farm while virtually neglecting other factors[4].

The appraisal of an individual farm for loan purposes involves two considerations, the security offered and the personal risk. While in the final analysis because of the uncertainty of the length of human life the amount loaned must depend largely on the security, the personal factor has too often been neglected. Since a farm loan organization is in business as a long-time proposition to give service to the agricultural industry, the maximum loan to be granted on an individual farm should be determined not merely by the amount which could be obtained should it be necessary to liquidate the security but by the annual payments which a farmer may be in a

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[3] Murray, W. G., "The Land Appraisal Problem", Journal of Farm Economics, October, 1934. Hammer, C. H., "The Accuracy and Flexibility of Rural Real Estate Assessment in Missouri", Missouri Agr. Exp. Sta. Bulletin 169, 1932. Hudson, S. C., "Rural Taxation in Ontario", Dominion Department of Agriculture Technical Bulletin No. 4.

[4] For a discussion of factors affecting security of loans, see Hill, F. F., "An Analysis of the Loaning Operations of the Federal Land Bank of Springfield", Cornell Bulletin 549, 1932.

position to make under normal conditions after paying the necessary operating expenses and obtaining a reasonable standard of living for himself and family. Many small unproductive farms while having a sale value have no loan value due to the fact that after paying operating expenses and yielding even a meagre standard of living to the family, nothing is left to cover payments of interest and principal. On the other hand, under some circumstances, a farmer might be able to service a larger loan than the market value would appear to justify. In the appraisal of the personal risk consideration should be given to the applicant's ability as a farmer, his age, education and experience, financial progress, character and reputation in the community and finally his family—are they likely to be an asset or a liability in the repayment of his loan.

In the appraisal of the farm itself, one of the most important factors is the community. It is apparent that the risks of loss are at a minimum on a farm in a prosperous community which has good roads, schools and churches, adequate market facilities, modern conveniences such as mail delivery, telephone and electricity and a high type of citizen. In rating the farm itself, careful consideration must be given to the production factors including type of farming to which adapted, quality, desirability and crop adaptation of soil, size of business, adequacy and condition of buildings, farm layout, water supply, improvements, convenience of operation and home attractiveness.

Finally, one of the greatest problems in appraisal is the appraiser himself. For any task with a degree of complexity so great as that of appraisal, a man of unusual ability is required. One of the first qualifications for a good appraiser is honesty. An appraiser has a two-fold responsibility and must discharge it in a manner which is fair to both borrower and lender. A second pre-requisite is common sense. He must be mentally alert and open-minded. He must have the ability to analyze and having analyzed, to make a decision. He must have a broad training in scientific agriculture and farm management and must be familiar with the farmers' problems and the farmers' point of view. Having found a man who embodies the above attributes, he must be equipped with the necessary aids such as information on the soils and land classification of his area, price data, land valuations and information concerning the relation of the various appraisal factors to loan risk.

While we in Canada have a long way to go before we can hope for the solution of all of the problems which have been discussed, the recognition of the fact that they exist is in itself a movement in the right direction.

The Department of Farm Management, University of Saskatchewan, in co-operation with the Economics Branch of the Dominion Department of Agriculture, is conducting a land utilization survey in southern Saskatchewan. A similar study is being carried on by the Economics Branch in co-operation with the Provincial Department of Agriculture in Alberta. Field parties are now at work in both provinces.

The eighteenth annual meeting of the American Institute of Cooperation was held at the University of Illinois, Urbana, Illinois, June 15th to 19th. The registration was approximately 1,800, the largest in the history of the Institute. The program was featured by a series of lectures by J. R. Barton on the philosophy of cooperation. Among the speakers on the regular program were C. C. Teague, California Fruit Growers Association; Quentin Reynolds of the Eastern States Farmers Exchange; C. W. Peterson, Farm and Ranch Review, Calgary; Chester Davis, Agricultural Adjustment Administration, Washington, D.C.; H. R. Tolley, Agricultural Adjustment Administration, Washington, D.C.; Dr. A. G. Black, Bureau of Agricultural Economics, Washington, D.C.; Dr. F. W. Peck and Dr. O. B. Jesness, University of Minnesota; Lyn Edminster, State Department, Washington, D.C.; H. C. Case, Agricultural Economics Department, University of Illinois, and Dr. M. P. Rasmussen, Cornell University.

MORE FACTS CONCERNING MILK CONSUMPTION IN CANADA[1]

G. P. Boucher[2]

The main purpose of this article is to give some additional figures obtained in connection with the milk and cheese consumption survey of 1935. The article which appeared in the last issue of the Economic Annalist dealt mostly with the consumption of milk. The present discussion will aim to show the proportion of children who do not drink milk and the proportion of those who drink beverages other than milk in the three Canadian cities, villages and rural areas in which the study was carried on.

The first table shows the relation between family income and the proportion of children in three age groups who do not consume milk as a beverage in the three cities of Oshawa, Quebec and Calgary. With an increase in the family income, there is a decrease in the number of children not drinking milk. Except in the city of Oshawa, there is a greater proportion of girls than boys not drinking milk. The city of Calgary shows a smaller number of children not drinking milk than the other two

Table 1.—Relation between family income and non-consumption of milk as a beverage by 3,939 children of various age groups in 2,602 families in the cities of Oshawa, Quebec and Calgary, 1935

Family income	Total children	Percentage of children not drinking milk								
		Boys			Total for boys	Girls			Total for girls	Total for all children
		Under 6 years	6–12 years	13–16 years		Under 6 years	6–12 years	13–16 years		
		%	%	%	%	%	%	%	%	%
City of Oshawa—										
On Relief	72	20	15	33	21	8	25	13	15	18
Under $1,000	458	17	27	47	27	11	31	44	27	27
$1,000–$2,000	397	12	25	24	19	5	21	30	17	18
$2,000–$4,000*	100	11	14	17	14	6	35	11	20	16
Total	1,027	14	23	34	22	7	26	34	21	21
City of Quebec—										
On Relief	142	22	42	91	41	32	50	69	44	43
Under $1,000	631	15	38	48	31	17	44	52	34	32
$1,000–$2,000	611	8	23	20	16	10	28	34	24	20
$2,000–$4,000	280	2	3	23	6	6	9	40	14	9
$4,000 and over	151	10	6	5	7	7	10	15	11	8
Total	1,815	11	24	33	20	15	29	41	26	23
City of Calgary—										
On Relief	125	19	38	42	32	36	34	18	30	31
Under $1,000	273	14	27	42	19	12	27	61	31	24
$1,000–$2,000	393	3	8	25	9	4	13	32	17	12
$2,000–$4,000†	229	6	8	20	10	—	11	19	10	10
Total	1,020	8	18	30	14	9	18	33	20	16
All three cities—										
On Relief	339	21	33	56	33	28	38	34	33	33
Under $1,000	1,362	15	47	46	27	14	36	52	31	29
$1,000–$2,000	1,401	8	18	23	15	7	23	32	20	17
$2,000–$4,000	609	5	6	21	7	10	9	37	17	11
$4,000 and over	228	7	3	4	4	4	7	12	7	6
Total	3,939	11	23	32	19	11	23	37	31	21

* In the income group, $4,000 and over, there were 30 children all consuming milk.
† In the income group, $4,000 and over, there were 47 children all consuming milk.

[1] Preliminary statement subject to revision and correction.
[2] Field Assistant, Economics Branch, Department of Agriculture, Ottawa.

cities. In most cases, there is an increase in the proportion of children not drinking milk corresponding with the increase in age of the children.

Table 2 gives the proportion of children within various age groups who do not drink milk in three villages and five rural areas. These localities are the same as those described in the last issue of the Economic Annalist. With the increase in

TABLE 2.—NON-CONSUMPTION OF MILK AS A BEVERAGE BY CHILDREN IN VARIOUS AGE GROUPS IN 611 FAMILIES IN THREE VILLAGES AND FIVE RURAL AREAS IN THE PROVINCES OF QUEBEC, ONTARIO AND ALBERTA

Locality	Total children	Percentage of children not drinking milk								
		Boys			Total for boys	Girls			Total for girls	Total for all children
		Under 6 years	6–12 years	13–16 years		Under 6 years	6–12 years	13–16 years		
		%	%	%	%	%	%	%	%	%
Villages	313	15	30	53	30	13	33	46	29	29
Rural cheese areas	189	2	—	17	3	11	18	15	14	8
Rural non-cheese areas	352	23	26	33	27	19	38	35	31	44
Rural areas	643	13	15	25	16	14	25	28	21	19

age, there is an increase in the proportion of children not drinking milk for every locality. The proportion of children not drinking milk is much higher in the villages than in the rural areas. It is also much higher in the rural non-cheese producing areas than in the rural cheese producing areas.

TABLE 3.—RELATION BETWEEN FAMILY INCOME AND NON-CONSUMPTION OF MILK AS A BEVERAGE BY CHILDREN FROM 3,213 URBAN AND RURAL FAMILIES IN THE PROVINCES OF QUEBEC, ONTARIO AND ALBERTA, 1935

Family income	Total children	Percentage of children not drinking milk								
		Boys			Total for boys	Girls			Total for girls	Total for all children
		Under 6 years	6–12 years	13–16 years		Under 6 years	6–12 years	13–16 years		
		%	%	%	%	%	%	%	%	%
Relief	354	22	35	53	34	29	38	33	33	33
Under $1,000	1,965	14	30	44	27	16	36	47	30	28
$1,000–$2,000	1,655	9	18	25	16	7	23	34	21	18
$2,000–$4,000	674	4	6	21	8	4	15	25	13	10
$4,000 and over	239	7	3	4	4	4	7	11	7	6
Not stated	8	—	—	—	—	—	—	—	—	—
Total	4,895	11	21	33	20	12	27	37	24	22

Table 3 is designed to show the relation between family income and non-consumption of milk by children for all the localities that have been under study. It shows an inverse relationship between family income and the number of children not drinking milk, there being a range from 33 for those on relief and 28 for those having a family income of less than $1,000, to 6 with those families having an income of over $4,000 a year. A greater proportion of girls than of boys do not drink milk and there is a smaller consumption of milk with an increase in age as is also seen in Tables 1 and 2.

The next three tables deal with the consumption of beverages other than milk by children of various age groups. These tables have been arranged in the same way as the three preceding ones in order to make comparisons possible. The relation between family income and the consumption of beverages other than milk by children for the three cities mentioned previously is shown in Table 4. A greater consumption of such beverages with an increase in age is easily noticed. However, there is a decrease in consumption with an increase in family income. This might be explained by the fact that more children drink milk in the larger income groups as shown in the Tables 1, 2 and 3 which emphasize non-consumption of milk. A slightly larger proportion of girls than boys drink beverages other than milk. This does not hold true for the city of Oshawa, however, where the proportion is somewhat higher for boys than for girls.

TABLE 4.—RELATION BETWEEN FAMILY INCOME AND CONSUMPTION OF BEVERAGES OTHER THAN MILK BY 3,939 CHILDREN WITHIN VARIOUS AGE GROUPS IN 2,602 FAMILIES IN THE CITIES OF OSHAWA, QUEBEC AND CALGARY, 1935

Family income	Total children	Percentage of children drinking other beverages								
		Boys			Total for boys	Girls			Total for girls	Total for all children
		Under 6 years	6–12 years	13–16 years		Under 6 years	6–12 years	13–16 years		
		%	%	%	%	%	%	%	%	%
City of Oshawa—										
On Relief	72	70	65	100	74	46	58	75	58	67
Under $1,000	458	51	62	63	58	45	57	66	55	57
$1,000–$2,000	397	23	49	51	36	29	42	43	32	34
$2,000 and over	130	14	16	33	19	13	32	44	26	22
Total	1,057	38	52	58	48	33	49	55	45	47
City of Quebec										
On Relief	142	31	38	73	41	43	55	77	53	47
Under $1,000	631	25	58	72	47	37	61	79	54	51
$1,000–$2,000	611	17	41	31	29	19	43	52	37	33
$2,000 and over	431	15	26	31	22	13	22	49	25	24
Total	1,815	21	43	47	35	28	43	62	42	38
City of Calgary—										
On Relief	125	57	75	67	68	43	76	65	65	66
Under $1,000	273	30	57	67	49	34	68	73	58	53
$1,000–$2,000	393	24	47	33	40	43	43	58	49	50
$2,000 and over	276	30	27	23	26	19	28	38	29	28
Total	1,067	30	72	44	41	34	49	58	47	43
All three cities—										
On Relief	339	46	60	78	58	44	65	71	58	58
Under $1,000	1,362	35	59	67	52	39	61	74	55	53
$1,000–$2,000	1,401	22	45	37	34	28	43	52	40	37
$2,000 and over	837	20	25	29	24	15	25	44	26	25
Total	3,939	28	52	49	40	31	46	59	44	42

There is a much larger proportion of children consuming beverages other than milk in villages (Table 5) than in rural areas. The proportion of children consuming such beverages is also very much smaller in rural cheese producing areas than in rural non-cheese areas. There is also a direct relationship between age and the consumption of beverages other than milk except in the case of girls in villages in which

TABLE 5.—RELATION BETWEEN FAMILY INCOME AND CONSUMPTION OF BEVERAGES OTHER THAN MILK BY 643 CHILDREN WITHIN VARIOUS AGE GROUPS IN 611 FAMILIES IN THREE VILLAGES AND FIVE RURAL AREAS IN THE PROVINCES OF QUEBEC, ONTARIO AND ALBERTA

Family income	Total children	Percentage of children drinking other beverages								
		Boys			Total for boys	Girls			Total for girls	Total for all children
		Under 6 years	6–12 years	13–16 years		Under 6 years	6–12 years	13–16 years		
		%	%	%	%	%	%	%	%	%
Villages	313	25	41	56	39	23	45	31	34	37
Rural cheese areas	189	13	5	17	7	9	15	15	12	9
Rural non-cheese areas	352	8	23	19	17	10	20	33	19	18
Rural areas	643	14	18	25	18	13	25	35	21	20

TABLE 6.—RELATION BETWEEN FAMILY INCOME AND CONSUMPTION OF BEVERAGES OTHER THAN MILK IN 3,213 URBAN AND RURAL FAMILIES IN THE PROVINCES OF QUEBEC, ONTARIO AND ALBERTA, 1935

Family income	Total children	Percentage of children drinking other bevergesa								
		Boys			Total for boys	Girls			Total for girls	Total for all children
		Under 6 years	6–12 years	13–16 years		Under 6 years	6–12 years	13–16 years		
		%	%	%	%	%	%	%	%	%
On Relief	354	47	60	74	58	45	67	70	59	59
Under $1,000	1,965	29	50	59	44	29	48	61	43	44
$1,000–$2,000	1,655	22	42	36	33	28	42	49	39	36
$2,000–$4,000	674	19	25	30	24	15	27	48	27	25
$4,000 and over	239	17	22	30	23	12	21	33	22	22
Not stated	8	—	50	—	33	100	33	100	60	50
Total	4,895	26	43	47	37	28	43	54	40	38

case no definite relationship seems to exist. There is also a larger proportion of girls than of boys drinking beverages other than milk in rural areas. The opposite is the case in villages.

Table 6, which is a summary of Tables 4 and 5, shows a larger proportion of children drinking beverages other than milk with an increase in age and a smaller proportion drinking such beverages with an increase in family income. A slightly larger proportion of girls than boys drink beverages other than milk.

A study of the cost of producing milk in Ontario has been undertaken by the Economics Branch of the Dominion Department of Agriculture and the Economics and Animal Husbandry Departments of the Ontario Agricultural College in co-operation with Milk Producers' organizations in the Province of Ontario. Account books have been distributed to dairy farmers who will record data for a period of a year after which it will be analysed by officers of the Economics Branch and the Ontario Agricultural College.

ECONOMIC ASPECTS OF APPLE PRODUCTION IN ROUVILLE COUNTY, QUEBEC

A. Gosselin[1]

A summary of the financial returns and the cost of producing apples on 30 orchard farms of Rouville County was presented in the June issue of this periodical[2]. This article will deal with the cost of marketing apples, the price of apples, the cash outlay for operating bearing orchards and man labour requirements on apple crop.

Apples Trucked and Sold at Public Markets.—A large number of growers of this district truck their apples to Montreal public markets where they either retail them to individual buyers or sell them to grocery and fruit stores. In 1932 ten growers sold 22 per cent of the total crop harvested on the 30 orchards included in this study through this channel. In 1933 the quantity of apples sold at public markets by 12 growers amounted to 28 per cent and in 1934 fifteen growers marketed in the same way 37 per cent of the total crop of the 30 orchards.

While this method of marketing presents several weaknesses, it nevertheless offers to many growers an opportunity to dispose of low grade apples which would not be used otherwise, and provides work at a time of the year during which there is little to do in the orchard. The proximity of a large consuming centre like Montreal combined with the practice followed by many city people of buying a large part of their fruits and vegetables at public markets explain the popularity of this method of marketing apples. It is claimed, however, that the sale of a large quantity of low grade apples spoils the market for the good ones and that, from the consumer's standpoint, it is a poor bargain because of the considerable waste resulting from their use.

The cost of trucking and selling apples at public markets itemized in Table 5 shows that the two major items of cost are the use of the motor truck and labour required for handling and selling. The same containers are often used from year to year and this item amounts to very little. The item "other costs" is made up of bridge tolls, market fees and board of the operator while he is away from home.

Table 5.—Cost of marketing apples at public markets

Item of cost per barrel	1932	1933	1934	3-year average
	cents	cents	cents	cents
Labour for grading, packing, hauling to market and selling	0.22	0.25	0.32	0.26
Containers	0.05	0.08	0.02	0.05
Truck expenses	0.27	0.26	0.26	0.27
Other costs	0.08	0.09	0.12	0.09
Total marketing costs	0.62	0.68	0.72	0.67

The average price per barrel of apples sold at public markets was $2.65 in 1932, $2.35 in 1933, $3.25 in 1934 and $2.69 for the three-year period.

Apples Sold at the Farm.—Most apple growers in this district sell their crop to wholesalers and truckers at the farm. Apples sold to wholesalers are graded and packed in barrels usually supplied by buyers. The main item of cost in this case is made up of labour required for grading and packing. Apples sold to truckers are roughly graded in open packages and the buyers exchange the containers or return them to the growers.

[1] Economist, Agricultural Economics Branch, Ottawa.
[2] See the *Economic Annalist*, Vol. VI, No. 3, pp. 44–48.

The cost of grading, packing and handling apples sold at the farm to wholesalers or truckers averaged 23 cents per barrel for the three years 1932-1934. The average price per barrel received by growers was $1.84 in 1932, $1.92 in 1933, $2.79 in 1934 and $2.00 for the three-year period.

It is very difficult to make comparison of the prices received by growers who market their apples through various methods because it is almost impossible to secure accurate data on varieties and grades handled in each case.

Cost of Marketing Apples.—Several methods are used by apple growers of this district for the disposal of their crop. A certain number sell their apples to truckers and wholesalers at the farm. Others truck their apples to Montreal and retail them at public markets. A few dispose of a part of their crop at roadside stands. In Abbotsford, where a co-operative packing plant was organized a few years ago, a large portion of the crop harvested by the growers included in this study was marketed through that plant for the year 1932 but practically none in 1933 and 1934. The cost of marketing apples given in Table 6 represents the average cost to dispose of the total crop of these growers through various methods.

The average cost of marketing the apple crop in this district is rather low for the reason that most growers retailing their apples at public markets use the same containers from year to year, while those selling to truckers exchange them. The only apples boxed were those sold through the co-operative packing plant at Abbotsford. The higher marketing cost per barrel recorded in 1932 is explained by the fact that a portion of the crop was handled through the co-operative packing plant where the total handling charge amounted to 36 cents per bushel hamper for summer varieties and 60 cents per box for winter varieties or $1.80 per barrel. The box alone cost 24 cents. Of course the price received for boxed apples was correspondingly much higher than the average price for the whole crop.

TABLE 6.—COST OF MARKETING APPLES PER BARREL ON 30 ORCHARD FARMS IN ROUVILLE COUNTY, QUEBEC, 1932–1934

Item of cost per barrel	1932	1933	1934	3-year average
	cents	cents	cents	cents
Labour for grading, packing, hauling to market and selling	0.16	0.17	0.21	0.17
Containers	0.21	0.07	0.03	0.13
Other expenses	0.22	0.17	0.17	0.19
Total marketing costs	0.59	0.41	0.41	0.49

Cash Outlay for Operating Bearing Orchard.—While from a general point of view and for the purpose of comparison between various type of farm enterprises it is useful to calculate the cost of production according to some standard method, most farmers are particularly interested to know the cash outlay required for producing and marketing their crop.

They want to know the margin between their cash operating expenses and cash returns for they depend on that to pay for the use of borrowed capital and their living expenses. The cash expenses required for operating a bearing orchard consist of hired labour, purchased feed for horses, spray material, fertilizers, containers, trucking and selling apples, taxes, repairs to buildings and equipment and a few other minor expenses.

The average cash expenses per barrel for producing and marketing apples on these 30 orchards amounted to $1.00 in 1932, $0.88 in 1933 and $1.32 in 1934. The average for the three-year period was $1.01 per barrel. Since more hired help is

required for handling a heavy crop than a small one, up to a certain limit the cash expenses increase with the yield.

Price per Barrel of Apples.—The average price per barrel for all grades of all varieties of apples sold by the 30 growers was $2.14 in 1932, $2.00 in 1933, $2.94 in 1934, and $2.23 for the three-year period, while for the previous period it had been $3.17 in 1929, $3.33 in 1930, $2.66 in 1931 and $3.03 for the three years. It must be pointed out, however, that a good portion of the crop is made up of summer varieties which command a low price and a high percentage of the winter varieties are of very low grades. The wholesale price to the growers for No. 1 McIntosh apples varied from $3.25 to $3.50 per barrel in 1932, from $3.00 to $3.25 in 1933, and from $4.75 to $5.50 in 1934.

Man Labour Requirements on Apple Crop.—The amount of man labour required to perform various operations in the orchards prior to harvest does not vary much from year to year unless something unusual happens to the orchard as in 1934. The man labour requirements per acre for pruning trees, brush hauling, fertilizing, spraying, mowing, mulching and propping averaged 65.0 hours in 1932, 67.0 hours in 1933 and 58.0 hours in 1934. Man labour requirements for harvesting are closely related to the size of crop. In 1932, it required 69.0 man hours for picking and hauling an average yield of 81.6 barrels to the acre, 63.6 hours in 1933 with an average yield of 67.9 barrels and 30.8 hours in 1934 with an average yield of 32.6 barrels. The rate per man per day for picking is from 10 to 12 barrels and for grading by hand and packing from 12 to 15 barrels.

FARMERS' BUSINESS ORGANIZATIONS IN CANADA, 1934

W. F. CHOWN[1]

Agricultural co-operation in Canada for the year 1934 is summarized in the accompanying tables. During 1935, the Agricultural Economics Branch received returns from 697 farmers' business organizations that were active during 1934. This was an increase of 7 over the previous year. Quebec, Ontario and Saskatchewan returns were received chiefly through provincial officials. In the other provinces, questionnaires were mailed direct from Ottawa. The majority of the organizations included have been incorporated under provincial co-operative acts.

The 697 organizations had 2,604 branches which combined make a total of 3,301 places of business engaged in the marketing of farm products and the purchase of supplies for farmers. Shareholders and members financially interested numbered 341,020 and patrons were estimated to number 378,730. These organizations range in size from the small club serving local needs to the large association with a Dominion-wide field.

Total assets, after deducting provision for bad debts and depreciation, amounted to $105,183,565 of which the book value of plant and equipment was $38,850,488. The members equity amounted to $49,876,894, consisting of paid-up share capital $8,933,425, and reserves and surplus $40,943,469. Total assets had increased by $800,000, general liabilities had decreased by $700,000, resulting in an increase in net worth of $1,500,000 over the previous year. This indicates a healthy position, on the whole, for those reporting.

Sales of farm products amounted to $120,853,560, sales of supplies $9,241,755, and other revenue $289,576, or a total business of $130,384,891. The total volume of business decreased by $6,000,000 from the previous year. This was the result of a decrease in the value of farm products marketed amounting to $8,000,000 and an increase in the value of supplies sold amounting to $2,000,000. The 1933 grain crop was considerably smaller than that of the preceding year and though the price realized was slightly higher, the decrease in quantity handled accounts for practically all of this reduction.

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[1] Accountant Examiner, Agricultural Economics Branch.

Marketing.—Available records indicate that the most important early activity of farmers in the field of co-operation in Canada was directed toward the marketing of farm products. In comparing volume of business, marketing associations transacted twenty times the volume of business handled by purchasing agencies. Membership in the co-operative marketing associations was reported to be 312,519 persons compared with 27,328 members in purchasing organizations.

Within the marketing group the grain and seed co-operatives which include the wheat pools of Western Canada have the largest membership and investment, and exceed all other commodity groups in volume of business, which was estimated at $82,803,629 for the year under review. A membership of 170,081 grain growers contributed to this business through 2,137 co-operative marketing agencies. Mainly through deductions from the selling price of their grain, these members have invested a sum of $37,114,643 in their business and in addition have paid up $3,350,952 in share capital. Combined assets total $88,298,067.

One hundred and fifteen dairy co-operatives with 122 depots in Canada reported a membership of 35,034 with assets valued at $4,179,513. Paid-up share capital amounted to $1,828,967 with reserves of $723,675. Sales of dairy products totalled $8,479,466 for the year under review.

The records for 53 live-stock shipping and marketing associations showed a combined membership of 35,314. Financing of these associations has been mainly by membership fees and commissions. Assets were comparatively low, value of plant and equipment amounted to $616,292. The value of live stock marketed was $7,431,276. The live-stock co-operatives undertake very little processing of their product. Their main activity has been the assembling of live stock in cars at producing points for shipment to central markets.

A large part of the fruit and vegetable crop was marketed through 104 co-operative agencies with a combined membership of 9,307 fruit growers. Assets for all companies totalled $3,860,115; reserves and surplus amounted to $1,009,767. Sales of fruits and vegetables during the year amounted to $6,382,915 which, together with supplies and other revenue, gave a total business of $7,809,574.

Poultry producers have organized in each of the provinces to sell their products co-operatively. There were 24 associations with 247 places of business which reported a membership of 32,851 members. Assets amounted to $444,139 with reserves of $196,792. Sales for the year amounted to $2,068,402.

Practically all the wool marketed co-operatively in Canada is handled by the Canadian Co-operative Wool Growers Ltd. The company operates in each province through the medium of 18 sheep-breeders' and wool-growers' associations. This co-operative, stores, grades and markets the wool received from its 7,100 patrons. In addition it carries on advertising and educational work and handles materials and supplies for its members. The quantity of wool handled by the co-operative during the year amounted to 5,076,100 pounds.

In Ontario and Quebec, the honey producers are organized co-operatively with a combined membership of approximately 1,800 members. Two tobacco co-operatives in Ontario, and three in the province of Quebec reported a total membership of 842 and sales of approximately one and a quarter million dollars for 1934. The Producteurs de Sucre et Sirop d'Erable de Québec, with a membership of 1,982, is organized on a co-operative basis. During the year under review, maple products marketed by this association amounted to $293,322.

Purchasing.—Three hundred and thirty-three associations organized for the purpose of purchasing farm supplies and merchandise on the co-operative plan reported on their activities during 1934. These consumer associations, of which nearly one-half are established in the province of Saskatchewan, had a combined membership of 27,328. The sales value of supplies handled during the year, by associations organized exclusively for the handling of supplies, amounted to $5,198,825. In five of the provinces co-operative wholesale buying societies purchase goods for their shareholder associations.

For further information see accompanying tables.

FARMERS' BUSINESS ORGANIZATIONS IN CANADA, 1934. PROVINCIAL GROUPING

—	No. of associations	No. of places of business	No. of shareholders or members	No. of patrons	Total assets	Value of plant	General liabilities	Paid-up share capital	Reserves and surplus	Sales of farm products	Sales of supplies	Total business including other revenues
					$	$	$	$	$	$	$	$
British Columbia	69	83	12,817	14,405	3,812,828	1,290,548	1,169,538	1,751,905	891,385	7,252,916	1,477,146	8,765,292
Alberta	47	499	64,223	71,604	22,756,428	7,128,876	12,098,120	323,297	10,335,011	20,730,304	520,996	21,266,120
Saskatchewan	186	1,360	120,914	131,914	50,884,123	17,333,055	24,956,470	989,409	24,938,244	45,982,323	1,814,032	47,806,223
Manitoba	47	389	45,751	45,992	3,803,138	2,268,072	3,264,185	292,346	246,607	8,402,101	866,909	9,284,882
Ontario	117	130	33,729	41,677	3,148,741	1,393,991	1,261,859	1,110,279	776,603	11,446,004	1,389,173	12,916,565
Quebec	136	136	16,125	16,125	4,125,539	1,779,429	2,669,449	693,506	762,584	8,210,858	221,540	8,525,197
New Brunswick	21	60	3,577	4,581	274,635	67,152	97,801	71,280	105,554	420,132	452,267	873,063
Nova Scotia	55	87	5,356	8,401	1,656,160	675,746	975,052	405,329	275,779	1,439,526	885,934	2,340,732
Prince Edward Island	14	88	8,415	8,931	130,727	45,634	118,902	13,320	−1,495	813,587	152,154	966,716
Interprovincial	5	469	30,113	35,100	14,591,246	6,867,985	8,695,295	3,282,754	2,613,197	16,155,809	1,461,604	17,640,101
Total	697	3,301	341,020	378,730	105,183,565	38,850,488	55,306,671	8,933,425	40,943,469	120,853,560	9,241,755	130,384,891

FARMERS' BUSINESS ORGANIZATIONS IN CANADA, 1934. COMMODITY GROUPING

—	No. of associations	No. of places of business	No. of shareholders or members	No. of patrons	Total assets	Value of plant	General liabilities	Paid-up share capital	Reserves and surplus	Sales of farm products	Sales of supplies	Total business including other revenues
Marketing—												
Dairy products	115	122	35,034	54,243	4,179,513	2,070,396	1,626,871	1,828,967	723,675	8,479,466	271,543	8,780,830
Fruits and vegetables	104	118	9,307	10,865	3,860,115	1,755,010	1,955,273	895,075	1,009,767	6,382,915	1,380,418	7,809,574
Grain and seed	30	2,137	170,081	170,029	88,298,067	32,343,910	47,832,472	3,350,952	37,114,643	81,284,345	1,504,017	82,803,629
Live stock	53	275	35,314	47,606	982,445	616,292	240,393	683,102	58,950	7,431,276	263,478	7,749,583
Poultry	24	247	32,851	22,752	444,139	94,396	192,653	54,694	196,792	2,068,402	16,202	2,098,945
Honey	2	2	1,818	519	148,846	7,485	107,806	35,324	5,716	219,592	17,882	238,267
Maple sugar	1	1	1,982	1,982	305,132	228,592	180,369	56,905	67,858	293,322	—	293,322
Tobacco	5	5	842	692	443,117	105,180	97,850	72,721	272,546	1,284,063	—	1,285,086
Wool	1	19	2,104	7,100	287,317	76,890	30,532	116,240	140,545	594,346	76,652	693,686
Miscellaneous	5	16	23,186	23,186	3,077,935	1,034,542	2,209,641	635,749	232,545	12,381,382	512,738	12,962,142
Total	340	2,942	312,519	338,974	102,026,626	38,332,693	54,473,860	7,729,729	39,823,037	120,419,109	4,042,930	124,715,064
Purchasing	333	335	27,328	39,019	3,102,749	514,672	818,804	1,169,897	1,114,048	434,451	5,198,825	5,663,152
Miscellaneous	24	24	1,173	737	54,190	3,123	14,007	33,799	6,384			6,675
Total for Canada	697	3,301	341,020	378,730	105,183,565	38,850,488	55,306,671	8,933,425	40,943,469	120,853,560	9,241,755	130,384,891

AUTHOR INDEX

ARTICLES FRANÇAIS

ERRATA

In the article entitled "The reaction of wheat varieties to different dates of sowing" by J. B. Harrington and W. L. Horner appearing in the November, 1935, issue (Vol. 16 No. 3) on page 127, the following corrections should be made:—In Table 2, page 129, the first date of sowing should be April 15, and not April 5. In Figure 1 on page 130 in the left-hand margin of the cut, the yield in bushels per acre should read 25, 23, 21, 19, 17, 15 and 13, omitting the zeros which appear after these figures.

In the article entitled "Fertilizers for the black and gray soils of central Alberta" by F. A. Wyatt in the January, 1926, issue (Vol. 16 No. 5) two pages were omitted. These were printed and inserted loose in the succeeding issue as pages 240a and 240b to be pasted in their proper place following page 240. If this sheet cannot be located, a copy may be secured free of charge from the C.S.T.A., Box 625, Ottawa.